WATER SCARCITY & CLIMATE CHANGE: Growing Risks for Businesses & Investors

February 2009

A Ceres Report

Ceres

PACIFIC INSTITUTE

Authored by the Pacific Institute

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Ceres commissioned this report from the Pacific Institute.

Ceres is a national coalition of investors, environmental groups and other public interest organizations working with companies to address sustainability challenges such as global climate change. Ceres directs the Investor Network on Climate Risk, a group of more than 75 institutional investors and financial firms from the U.S. and Europe managing over $7 trillion in assets.

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

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Foreword from Ceres & the Pacific Institute

Most Western societies take clean water for granted. When we turn on the tap, we rarely question the source, its reliability or its quality. Perhaps out of habit, we assume there will always be more.

Water is one of our most critical resources – even more important than oil. Water sustains agriculture and, thus, our food chain. Vast quantities of water are used to make the silicon chips that help power our computers and cell phones. Electric power plants depend heavily on water, and account for a staggering 39 percent of freshwater withdrawals in the United States. It could be said our economy runs on water.

Yet, for all of its importance – to sustain our fast-growing global population and to ensure our future prosperity – few companies and investors are thinking strategically about the profound business risks that will exist in a world where climate change is likely to exacerbate already diminishing water supplies.

We're already seeing decreases in companies' water allotments, more stringent regulations, higher costs for water, growing community opposition and increased public scrutiny of corporate water practices.

Drought attributable in significant part to climate change is already causing acute water shortages in large parts of Australia, Asia, Africa, and the United States. Just last month, California water officials warned that the state – whose enormous agricultural and computer industries are heavily water-dependent – is facing "the worst drought in modern history."[1] Shrinking snowcaps are reducing river flows and water supplies across China, India and Pakistan – countries where more than one billion people already lack access to safe drinking water and adequate sanitation.

The impact of water scarcity and declining water quality on business will be far-reaching. We're already seeing decreases in companies' water allotments, more stringent regulations, higher costs for water, growing community opposition and increased public scrutiny of corporate water practices.

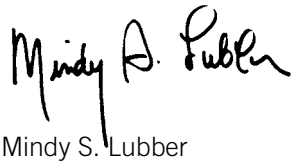
This Ceres/Pacific Institute report, done at the request of the Investor Network on Climate Risk, outlines the wide-ranging risks investors and companies face from water scarcity and how global climate change will heighten those risks in many parts of the world.

The report makes clear that companies that treat pressing water risks as a key strategic challenge will be far better positioned in the future. Companies that continue to ignore these challenges put themselves at higher risk.

1. Associated Press, "California Facing Worst Drought in Modern History," *USA Today*, January 30, 2009, See: http://www.usatoday.com/weather/drought/2009-01-30-california-drought_N.htm

Investors have a significant interest and role in catalyzing companies to look more closely at their potential risk exposure to water-related challenges. The report provides a first-of-its-kind list of key questions investors should ask to assess companies' ability to anticipate and respond to these challenges and transform them into opportunities.

Albert Einstein once said, "We shall require a substantially new manner of thinking if mankind is to survive." While he was speaking of another threat and in another era, Einstein's admonition is particularly germane here. Businesses and investors alike need to bring new ways of thinking to using the most essential ingredient of life: water.



Mindy S. Lubber
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President, Pacific Institute

Executive Summary

Water is crucial for the economy. Virtually every industry from agriculture, electric power and industrial manufacturing to beverage, apparel, and tourism relies on it to grow and ultimately sustain their business.

Yet water is becoming scarcer globally and every indication is that it will become even more so in the future. Decreasing availability, declining quality, and growing demand for water are creating significant challenges to businesses and investors who have traditionally taken clean, reliable and inexpensive water for granted. These problems are already causing decreases in companies' water allotments, shifts toward full-cost water pricing, more stringent water quality regulations, growing community opposition, and increased public scrutiny of corporate water practices.

This Ceres/Pacific Institute report concludes that climate change will exacerbate these water risks, especially as the world population grows by 50 million a year.

The most recent report by the Intergovernmental Panel on Climate Change (IPCC) states that global warming will lead to "changes in all components of the freshwater system," and concludes that "water and its availability and quality will be the main pressures on, and issues for, societies and the environment under climate change."[2] Nestlé's chairman Peter Brabeck-Letmathe puts it more bluntly, calling water availability a bigger challenge than energy security. "I am convinced that, under present conditions and with the way water is being managed, we will run out of water long before we run out of fuel."[3]

"I am convinced that... we will run out of water long before we run out of fuel."

Nestlé chairman Peter Brabeck-Letmathe

Already, China and India are seeing growth limited by reduced water supplies from depleted groundwater and shrinking glaciers that sustain key rivers. California is limiting agricultural water withdrawals due to drought. France, Germany and Spain were forced to shut down dozens of nuclear plants due to a prolonged heat wave and low water levels. Scientists say climate change was a contributing factor to all of these events, which had far-reaching business impacts.

This report identifies water-related risks specific to eight water-intensive industry sectors. Among the findings:

- **High-Tech:** Eleven of the world's 14 largest semiconductor factories are in the Asia-Pacific region, where water quality risks are especially severe. Semiconductor firms require vast amounts of ultra clean water – Intel and Texas Instruments alone used 11 billion gallons of water to make silicon chips in 2007. A water-related shutdown at a fabrication facility operated by these firms could result in $100-$200 million in missed revenue during a quarter, or $0.02 or $0.04 per share.
- **Beverage:** Coca-Cola and PepsiCo bottlers lost their operating licenses in parts of India due to water shortages and all major beverage firms are facing stiff public opposition to new bottling plants – and to bottled drinking water altogether. Nestlé Waters has been fighting for five years, for example, to build the United States' largest bottling plant in McCloud, California.

2. B.C. Bates, Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., "Climate Change and Water," Technical Paper VI of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, June 2008.
3. "A water warning: Peter Brabeck-Letmathe, chairman of Nestlé, argues that water shortage is an even more urgent problem than climate change," The Economist, November 19, 2008. See: http://www.economist.com/theworldin/PrinterFriendly.cfm?story_id=12494630

- **Agriculture:** Reduced water availability is already impacting food commodity prices, as shown by last year's sharp increase in global rice prices triggered by a drought-induced collapse of rice production in Australia. Roughly 70 percent of the water used globally is for agriculture, with as much as 90 percent in developing countries where populations are growing fastest.

The report also identifies water-related risks for **electric power/energy**, **apparel**, **biotechnology/pharmaceutical**, **forest products** and **metals/mining** firms. For companies in these and other sectors, climate change will further reduce the availability of reliable and high quality water, impacting productivity, costs, revenues, public goodwill and reputation.

The report highlights the intensifying conflict between energy use and water availability. With increasing frequency, choosing one of these resources means undermining the other – the other, usually being water. For example, the billions of dollars spent to expand oil sands development in Canada and corn-based ethanol production in the U.S. has incrementally increased fuel supplies, but at the expense of significant water impacts and greenhouse gas emissions that could ultimately limit these ventures in the future.

Despite these looming challenges, the report concludes that businesses and investors are largely unaware of water-related risks or how climate change will likely exacerbate them.

To address this poorly recognized challenge, increased corporate water risk disclosure is vital. "A scarcity of clean, fresh water presents increasing risks to companies in many countries and in many economic sectors," concludes JPMorgan in a March 2008 report. "These risks are difficult for investors to assess, due both to poor information about the underlying supply conditions and to fragmentary or inadequate reporting by individual companies."[4]

It is increasingly critical, therefore, that company executives and directors better understand and disclose the interplay among these diverse risks as well take action to address them.

To evaluate and effectively address water risks, companies should take the following actions:

1. Measure the company's water footprint (i.e., water use and wastewater discharge) throughout its entire value chain, including suppliers and product use.
2. Assess physical, regulatory and reputational risks associated with its water footprint, and seek to align the evaluation with the company's energy and climate risk assessments.
3. Integrate water issues into strategic business planning and governance structures.
4. Engage key stakeholders (e.g., local communities, non-governmental organizations, government bodies, suppliers, and employees) as a part of water risk assessment, long-term planning and implementation activities.
5. Disclose and communicate water performance and associated risks.

Similarly, investors should pursue the following steps to better understand potential water-related exposure in their portfolio companies:

1. Independently assess companies' water risk exposure.
2. Demand more meaningful corporate water disclosure.
3. Encourage companies to incorporate water issues into their climate change strategies.
4. Emphasize the business opportunity side of the water challenge.

4. Marc Levinson et al., "Watching water: A guide to evaluating corporate risks in a thirsty world," JPMorgan Global Equity Research, March 31, 2008.

1. Global Water Trends and Climate Change

1.1 Major Themes

In recent years, the business implications of climate change have gained considerable recognition among companies and investors. However, much of this attention has focused on energy policy and greenhouse gas (GHG) emissions, while neglecting the implications of changing precipitation patterns and resulting water scarcity and water quality risks. Despite a growing consensus among climate experts that freshwater is one of the resources most vulnerable to long-term climate change (**Figure 1**), there is little awareness and discussion about the potential consequences for businesses and their shareowners.

Indeed, climate-related impacts on water resources are already being documented, causing real and imminent business risks. In all corners of the world, including many parts of North America, there is growing physical evidence of increased severe weather events, flooding and diminished ice cover, all of which are attributed to climate change. Numerous scientific studies also show increases in the intensity, duration and spatial extent of droughts associated with higher temperatures, warmer sea surface temperatures, changes in precipitation patterns and diminishing glaciers and snowpack (**see Table 1**).[5]

Table 1: Observed Changes in North American Water Resources During the Past Century (▲=increase ▼=decrease)

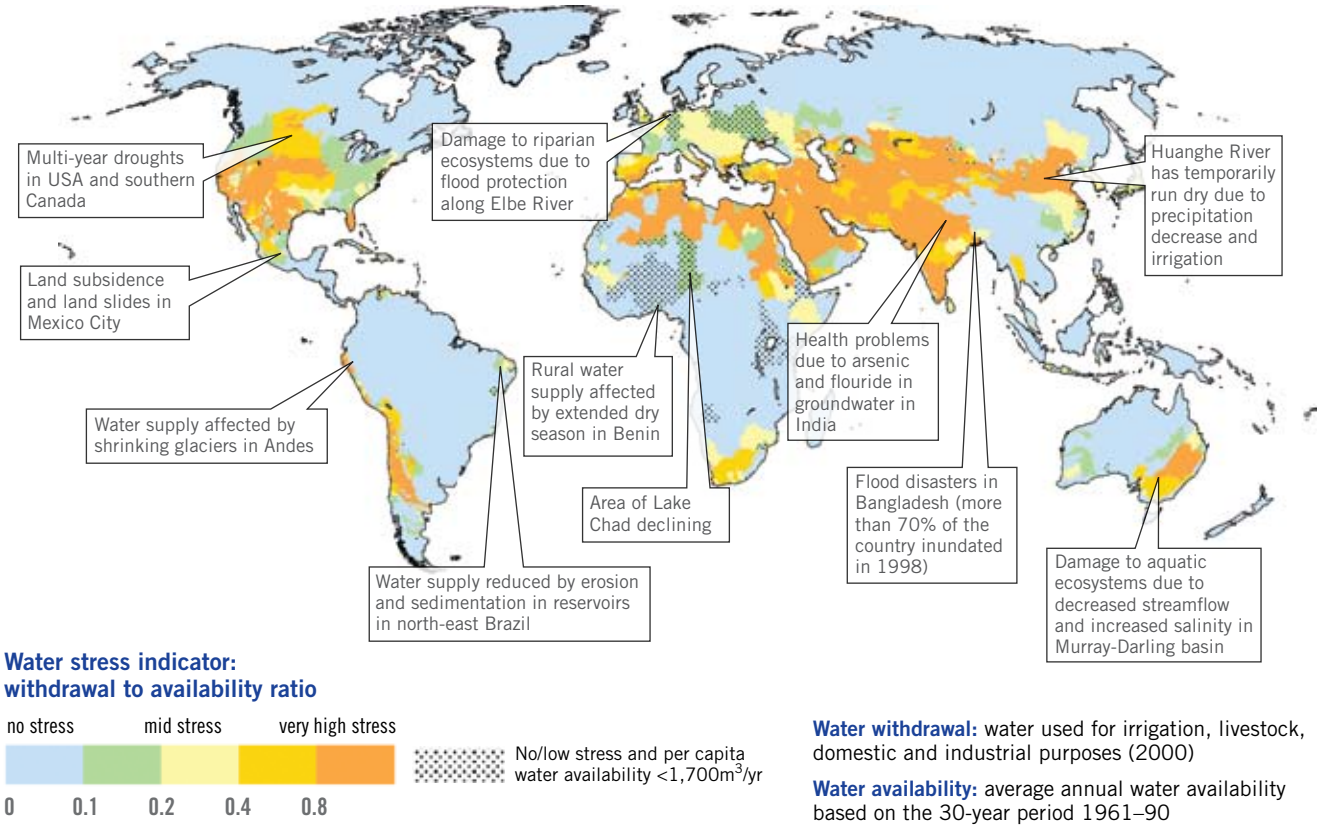
	Water Resource Change	Affected Region
	1–4 week earlier peak streamflow due to earlier warming-driven snowmelt	U.S. West and New England regions, Canada
▼	Proportion of precipitation falling as snow	Western Canada and prairies, U.S. West
▼	Duration and extent of snowcover	Most of North America
▲	Annual precipitation	Most of North America
▼	Mountain snow water equivalent	Western North America
▼	Annual precipitation	Central Rockies, southwestern U.S., Canadian prairies, eastern Arctic
▲	Frequency of heavy precipitation events	Most of U.S.
▼	Runoff and streamflow	Colorado and Columbia River basins
	Widespread thawing of permafrost	Most of northern Canada and Alaska
▲	Water temperature of lakes (0.1-1.5˚C)	Most of North America
▲	Streamflow	Most of the eastern U.S.
	Glacial shrinkage	U.S. western mountains, Alaska and Canada
▼	Ice cover	Great Lakes, Gulf of St. Lawrence
	Salinization of coastal surface waters	Florida, Louisiana
▲	Periods of drought	Western U.S., southern Canada

Source: B.C. Bates, Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., "Climate Change and Water," IPCC Technical Paper VI of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, June 2008

5. IPCC, "Climate Change 2007: The Physical Science Basis," Contributions of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge and New York: Cambridge University Press, 2007.

Below, we describe key water-related challenges likely will be exacerbated by climate change in many parts of the world.

Figure 1. Examples of Global Freshwater Resource Risks



Source: B.C. Bates et al. "Climate Change and Water IPCC," Technical Paper VI of the Intergovernmental Panel on Climate Change.

Increasing water demand

Existing challenge:

Population growth and economic development are driving significant increases in agricultural and industrial demand for water. Agriculture accounts for more than two-thirds of global water use, including as much as 90 percent in developing countries[6] (**Figure 2**). Freshwater consumption worldwide has more than doubled since World War II and is expected to rise another 25 percent by 2030.[7] Much of the growth is the result of expected increases in the world population from 6.6 billion currently to about 8 billion by 2030 and over 9 billion by 2050.

6. "Statistical Yearbook for Asia and the Pacific 2007," Economic and Social Commission for Asia and the Pacific, United Nations, New York, 2007. See: http://www.unescap.org/STAT/data/syb2007/26-Water-use-syb2007.asp
7. Daniel Wild, Carl-Johan Francke, Pierin Menzli and Urs Schön, "Water: a market of the future – Global trends open up new investment opportunities," Sustainability Asset Management (SAM) Study, Zurich, December 2007.

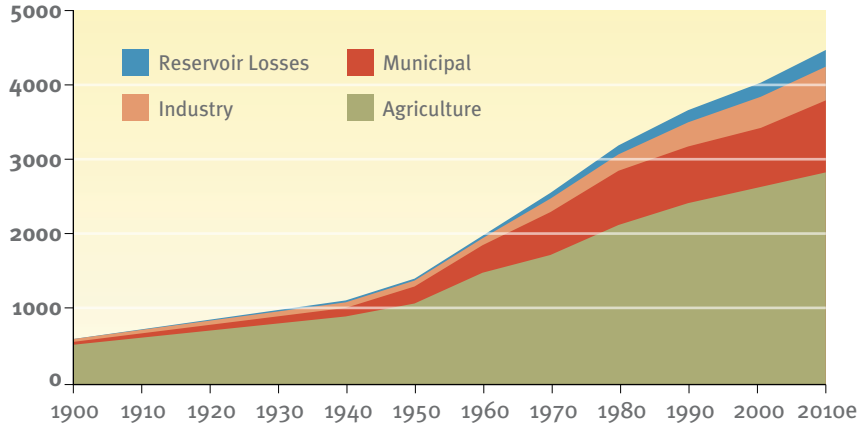
Climate change will likely:

- Increase water demand for agriculture, primarily for irrigation, due to prolonged dry periods and severe drought. Some research estimates an over 40 percent increase in irrigated land by 2080.[8]
- Increase water demand for hydration needs for billions of farm animals due to higher atmospheric temperatures.
- Increase quantities of water needed for industrial cooling due to increased atmospheric and water temperatures.[9]

Business impacts may include:

- Higher costs for water.
- Regulatory caps for water use.
- Conflicts with local communities and other large-scale water users.
- Growing demand for water efficient products and technologies.

Figure 2. Water Withdrawal by Sector (in Cubic Kilometers)



Source: UNESCO as cited in Zoe Knight and Robert Miller-Bakewell, "Water scarcity; A bigger problem than assumed," Merrill Lynch Equity Strategy Report, December 6, 2007. See: http://www.ml.com/media/86941.pdf

Water scarcity and unsustainable supply

Existing challenge:

Water is already over-appropriated in many regions of the world. More than one-third of the world's population – roughly 2.4 billion people – live in water-stressed countries and by 2025 the number is expected to rise to two-thirds.[10] Groundwater tables and river levels are receding in many parts of the world due to human water use. In India, for example, farmers

8. Günther Fischer, Francesco N. Tubiello, Harrij van Velthuizen and David A. Wilberg, "Climate change impacts on irrigation water requirements: Effects of mitigation, 1990–2080." Technological Forecasting and Social Change 74, no. 7 (September 2007): 1083-1107.
9. B.T. Smith et al., "Climate and thermoelectric cooling linkages," Potential Effects of Climate Change in Thermoelectric Cooling Systems, Oak Ridge National Laboratory. Oak Ridge, Tennessee, 2005.
10. "Making Every Drop Count." UN-FAO press release, February 14, 2007.

are now using nearly 80 percent of the country's available water, largely from groundwater wells; at current rates, the World Bank estimates that India will have exhausted available water supplies by 2050.[11] Regions affected by drought also are increasing. The percentage of global land classified as "very dry" has doubled since the 1970s, including large parts of Africa and Australia.[12] Natural water storage capacity and long-term annual river flows are also declining, especially in the Northern Hemisphere, due to glacial/snowcap melting. Glacial melting is one of the reasons that many of Asia's largest rivers are projected to recede in coming decades. And reduced snowpack in the Rocky Mountains is the explanation given by scientists who say that Lake Mead, a key water source for millions of people in the southwestern United States, could dry up by 2021 if future water use is not limited.[13]

Climate change will likely:

- Decrease natural water storage capacity from glacier/snowcap melting, and subsequently reduce long-term water availability for more than one-sixth of the world's population that lives in glacier- or snowmelt-fed river basins, including major regions of China, India, Pakistan and the western U.S.
- Increase water scarcity due to changes in precipitation patterns and intensity. In particular, the subtropics and mid-latitudes, where much of the world's poorest populations live, are expected to become substantially drier, resulting in heightened water scarcity.[14] A new MIT study also shows that reduced precipitation in some arid regions could trigger exponentially larger drops in groundwater tables.[15]
- Increase the vulnerability of ecosystems due to temperature increases, changes in precipitation patterns, frequent severe weather events, and prolonged droughts. This will further diminish the ability of natural systems to filter water and create buffers to flooding.
- Affect the capacity and reliability of water supply infrastructure due to flooding, extreme weather, and sea level rise. Most existing water treatment plants and distribution systems were not built to withstand expected sea level rise and increased frequency of severe weather due to climate change.[16] Furthermore, climate change will concentrate snowmelt and precipitation into shorter time frames, making both water releases more extreme and drought events more sustained. Current infrastructure often does not have the capacity to fully capture this larger volume of water, and therefore will not be able to meet water demands in times of sustained drought.

11. Gleick, P. 2007. The World's Water 2006-2007: A Biennial Report on Freshwater Resources.
12. National Center for Atmospheric Research (NCAR), "Drought's Growing Reach: NCAR Study Points to Global Warming as Key Factor," The University Corporation for Atmospheric Research, January 10, 2005. See: http://www.ucar.edu/news/releases/2005/drought_research.shtml.
13. Tim P. Barnett and David W. Pierce, "When will Lake Mead go dry?" Water Resources Research, 44, Scripps Institution of Oceanography, University of California, San Diego, March 29, 2008. See: http://scrippsnews.ucsd.edu/Releases/?releaseID=876
14. Meehl et. al. 2007 Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change
15. David Chandler, "Water supplies could be strongly affected by climate change: Changes in rainfall can be amplified, up or down, in changes to aquifers," Massachusetts Institute of Technology News, December 18, 2008. See: http://web.mit.edu/newsoffice/2008/agu-groundwater-1218.html
16. Corinne J. Shuster-Wallace et al., "Safe Water as the Key to Global Health," United Nations University International Network on Water, Environment and Health, 2008.

- Impair non-consumptive water uses, including transportation on inland waterways such as the Mississippi River in the U.S. and Rhine River in Europe, where freight transport has already been disrupted due to floods and droughts.[17] Tourism sectors that are dependent on the availability of water or snow are also vulnerable to water scarcity due to climate change. Freshwater fisheries, many of which supply food to the world's poorest populations, also depend on abundant, high quality water resources to remain productive.

Business impacts may include:

- Decreased amount of water available for business activities.
- Increased costs for water.
- Operational disruptions and associated financial loss.
- Impacts on future growth and license to operate.

Declining water quality

Existing challenge:

Declining water quality is an acute problem around the world, particularly in developing countries where there are notable increases in agricultural and industrial production, coupled with a lack of adequate wastewater treatment. In many developing countries, waterways traditionally used for drinking water or other community needs have been heavily contaminated. In China, many rivers are so badly polluted that not even industry can use the water and nearly two-thirds of the country's largest cities have no wastewater treatment facilities.[18] Rising water demand and the lack of adequate sanitation facilities are key reasons why almost 900 million people worldwide lack access to safe drinking water and up to five million people die each year from water-related illness.[19]

Climate change will likely:

- Contaminate coastal surface and groundwater resources due to sea level rise, resulting in saltwater intrusion into rivers, deltas, and aquifers.
- Increase water temperatures, leading to more algal and bacterial blooms that further contaminate water supplies.
- Increase extreme precipitation and flooding, which will increase erosion rates and wash soil-based pollutants and toxins into waterways.
- Contribute to environmental health risks associated with water. For instance, changes in precipitation patterns are likely to increase flooding, and as a result mobilize more pathogens and contaminants.[20] It is estimated that by 2030 the risk of diarrhea will be up to 10 percent higher in some countries due to climate change.[21]

17. Martin Parry Ed., "Assessment of potential effects and adaptations to climate change in Europe: The Europe Acacia Project," Report of concerted action of the environment program of the Research Directorate General of the Commission of the European Communities, Jackson Environmental Institute, University of East Anglia, Norwich, 2000
18. Daniel Wild et al., "Water: a market of the future – Global trends open up new investment opportunities."
19. Ibid.
20. Corinne J. Shuster-Wallace et al., "Safe Water as the Key to Global Health."
21. A.J. McMichael et al., *Climate Change and Human Health: Risks and Responses*. World Health Organization. Geneva, 2003.

Business impacts may include:

- Increased costs for pre-treatment to obtain desired water quality.
- Increased costs for wastewater treatment to meet more stringent regulations.
- Regulatory restrictions for specific industrial activities and investments.
- Increased health costs for employees in the countries that are impacted.
- Increased responsibility (and costs) to implement community water infrastructure and watershed restoration projects to mitigate reputational risks.

Taken together, this means that businesses will face vastly increased uncertainty about the availability and quality of their water supplies. One of the strongest conclusions in the latest IPCC report is that "climate change will challenge the traditional assumption that past hydrological experience provides a good guide to future conditions."[22] Therefore, it becomes increasingly crucial for businesses to incorporate climate change factors when assessing and managing their water risks.

1.2 The Water/Energy Collision

Water and energy are two critical ingredients of modern civilization. Without clean water, life cannot be sustained. Without energy, we cannot run computers, power homes or manufacture products. As the world's population grows in number and affluence, demand for both resources is increasing faster than ever, with far-reaching implications for both water scarcity and rising levels of global warming pollution.

Woefully underappreciated, however, is the fact that water and energy oftentimes compete with one another. We consume vast amounts of water to generate energy, and we consume vast amounts of energy to extract, process and deliver clean water. With increasing frequency, we value energy production over water protection. For example, the billions of dollars spent to expand oil sands development in Canada and corn-based ethanol production in the U.S. has incrementally increased fuel supplies, but at the expense of significant water impacts that could ultimately limit these ventures in the future.

This collision between energy and water – combined with the urgent need to reduce our global carbon footprint – will surely intensify in the coming years. Balancing these needs and potential risk factors will be a growing challenge for companies, investors and policymakers. These competing issues are intertwined in many ways:

- The electric power industry uses vast amounts of water overall, but there are wide disparities in water usage between different types of power production. For example, renewable energy sources such as wind and solar typically use low amounts of water compared to coal, nuclear, hydropower and biofuels (**see Table 2**).

22. B.C. Bates et al. "Climate Change and Water," IPCC Technical Paper VI

Table 2. Water Consumption by Energy Type in the United States

Energy type	Total water consumed per megawatt hour (m3/MWh)	Water consumption required for U.S. daily energy production (millions of m3)[23]
Solar	0.0001	0.011
Wind	0.0001	0.011
Gas	1	11
Coal	2	22
Nuclear	2.5	27.5
Oil	4	44
Hydropower	68	748
Biofuel (1st generation)	178	1958

Source: "Linking Water, Energy & Climate Change: A proposed water and energy policy initiative for the UN Climate Change Conference, COP15, in Copenhagen 2009," DHI, Draft Concept Note, January 2008. See: http://www.semide.net/media_server/files/Y/l/water-energy-climatechange_nexus.pdf

- First-generation biofuel[24] production has an especially large water footprint. The entire production cycle – from growing irrigated crops to pumping biofuel into a car – can consume 20 times as much water for every mile traveled compared to gasoline.[25] First-generation biofuel plantations can also compromise water quality through the leaching of pesticides and nutrients.[26]
- A large-scale replacement of the gasoline-guzzling U.S. vehicle fleet with plug-in electric vehicles – an important potential solution to reducing greenhouse gas emissions from tail pipes – would have significant implications for power production, and thus water use. According to studies done at the University of Texas at Austin, [27] generating electricity for a plug-in hybrid electric or all-electric vehicle requires as much as three times the water per mile as gasoline production given the country's current power mix.[28]
- Desalination, increasingly considered an option to meet growing water demand, is extremely energy intensive. In California, more energy is required to produce water from desalination than from any other water-augmentation or demand-management option. The future cost of desalinated water will be more sensitive to changes in energy prices than will other sources of water, presenting reliability risks.[29]

23. This column illustrates the consumptive water use associated with each production type, assuming that the entire energy production of the U.S. were based on that energy type only (based on current U.S. production of approximately 11 million MWh/day).
24. 'First-generation biofuels' are biofuels made from sugar, starch, vegetable oil, or animal fats using conventional technology, as opposed to 'second-generation' biofuels, such as cellulosic biofuels, which are derived from nonfood crops.
25. Michael E. Webber, "Energy Versus Water: Solving Both Crises Together," *Scientific American*, Scientific America, October 2008. See: http://www.sciam.com/article.cfm?id=the-future-of-fuel
26. Robert B. Jackson et al., "Trading Water for Carbon with Biological Carbon Sequestration," *Science* 310, no. 5756 (23 December 2005): 1944-1947. See: http://www.sciencemag.org/cgi/content/full/310/5756/1944
27. Michael E. Webber, "Energy versus Water: Solving Both Crises Together," Scientific American, Scientific America, October 2008. See: http://www.sciam.com/article.cfm?id=the-future-of-fuel
28. Of course, a significant change in power mix is likely to occur in the next decade, which would have a mitigating impact on water use.
29. Heather Cooley, Peter H. Gleick and Gary Wolff, "Desalination, With a Grain of Salt: A California Perspective," Pacific Institute for Studies in Development, Environment and Security, Oakland, California, June 2006.

- Water pipelines that transport water from water-rich to water-scarce regions – another popular solution for water scarcity – also require considerable amounts of energy (**Box 1**). The California Aqueduct, which transports snowmelt across two mountain ranges to two-dozen coastal cities, is the biggest electricity consumer in the state.[30]

A critical driver of success in the 21st century economy will be how companies and investors balance the competing demands for water and energy. Companies should be prepared to provide details on the risks they face from water challenges and to be transparent about the energy trade-offs they make to address them.

Box 1. Potential bond risk in Northern Nevada pipeline

Southern Nevada Water Authority (SNWA) officials are proposing to import 11 billion gallons of water a year from rural northeastern Nevada, nearly 300 miles away, to Las Vegas Valley. To accomplish this, SNWA plans to build a 285-mile water pipeline. Recent estimates peg the cost at $3.5 billion, but former federal water planner Mark Bird and others think the true costs could be as much as four times higher. SNWA plans to finance Nevada's largest-ever public works project with tax-exempt bonds. Given significant environmental concerns about the project, however, the bonds may present long-term risks. Critics of the project argue that the pipeline is a financial risk because it could go idle if groundwater levels in northeastern Nevada reach dangerously low levels, as some scientists expect could happen due to the project. Bondholders could be forced to renegotiate the terms of the bonds, or may find their bonds are worth little, if the project fails.

There are other reasons why the pipeline might not succeed. Opponents of the plan, including Clark County farmers, conservationists and Nevada Governor Jim Gibbons argue that high energy costs in withdrawing the groundwater and pumping it to Las Vegas make this proposal economically unattractive. Moreover, the water resources that will be pumped to Las Vegas under the proposal will not sustain the city's annual growth, not to mention its 40 million annual visitors.

Source: Phoebe Sweet. "Gibbons takes another whack at pipeline plan," Las Vegas Sun, February 21, 2008. See: http://wwwlasvegassun.com/news/2008/feb/21/gibbons-takes-another-whack-pipeline-plan/

30. Ronnie Cohen, Barry Nelson and Gary Wolff, "Energy Down the Drain: The Hidden Costs of California's Water Supply," Natural Resources Defense Council and Pacific Institute, Oakland, California, August 2004.

2. Analyzing Water-Related Business Risks

The aforementioned water scarcity problems, water quality problems, and climate-related impacts will be a major challenge to businesses in the years ahead. It is increasingly clear that the era of cheap and easy access to water is ending, posing a potentially greater threat to businesses than the loss of any other natural resource, including fossil fuel resources. This is because there are various alternatives for oil, but for many industrial processes, and for human survival itself, there is no substitute for water.

Company executives and investors have no choice but to boost their scrutiny of water-related risks, especially in regions where water supplies are already under stress. In this section, we build on our previous discussion by translating global water trends into a risk framework (i.e., physical, reputational, and regulatory) through which businesses and investors can understand their own water challenges. Again, it must be noted that climate change will likely exacerbate all three types of risks: physical, reputational and regulatory.

2.1 Physical Risks

Water scarcity directly impacts business activities, raw material supply, intermediate supply chain, and product use in a variety of ways. Declines or disruptions in water supply can undermine industrial and manufacturing operations where water is needed for production, irrigation, material processing, cooling and/or washing and cleaning. The semiconductor industry, for example, uses vast amounts of purified water in fabrication plants, for washing the silicon wafers at several different stages in the fabrication process and for cooling various tools; a brief water-related shutdown at a manufacturing plant could compromise all material in production for an entire quarter.[31]

Businesses' traditional water use estimates often fail to address water risks embedded in the supply chain. Water supply risks are often hidden in companies' raw material inputs or intermediate suppliers. Indeed, it can take more than 1,000 times as much water to produce some inputs than is used in all onsite activities.[32]

Local water scarcity in key geographic regions such as the western U.S., India or China (**see Box 2**) can also have far-reaching impacts on companies with operations or suppliers within those regions. The entire gaming industry, for example, has significant water scarcity exposure due to its huge presence in water-starved Las Vegas. The electronics industry faces potential exposure from its expanding manufacturing presence in Asian/Pacific Rim countries where water supplies are already under stress. Availability and affordability of clean water may also affect the interest or ability of customers to purchase or use certain water-intensive products and services.

31. Marc Levinson et al., "Watching water: A guide to evaluating corporate risks in a thirsty world," JPMorgan Global Equity Research, March 31, 2008.
32. "Remaining drops: Freshwater resources: A global issue," CLSA U, Pacific Institute and Bio Economic Research Associates, January 2006

Box 2. Water scarcity in northern China

Northern China has long-standing water scarcity problems. In September 2008, after four-plus years of construction on a $2 billion 191-mile waterway, the city of Beijing began receiving water from the less populated southern regions of China. While the North-South pipeline will briefly ease the region's water shortages, the Chinese government's official news agency recently said the capital's water supply could again reach a crisis point as early as 2010 due to population growth and rising domestic water consumption. Probe International, a Canadian environmental group, estimated that with Beijing's water reservoirs down to one-tenth of their capacity, two-thirds of Beijing's water supply is presently being drawn from underground. And Dai Qing, a Beijing-based water conservation activist, says the rapidly dropping water table threatens "geological disaster."

Chinese authorities have already shown a willingness to restrict water-intensive industries and will likely continue to do so in the future as water resources face unsustainable demands. A 2007 Draft Plan for National Economic and Social Development constrained the location of new textile, leather, metal smelting and chemical industries, according to China Daily reports. Beverage, plastics and pharmaceutical manufacturers were asked to meet water conservation restrictions in order to gain approval. Moreover, Beijing officials forced "water hungry" and polluting industries to close in Southern China (Hebei Province) to ensure sufficient water supplies for the capital.

Sources: "A shortage of capital flows: Going thirsty so Beijing can drink." The Economist, China's water-diversion scheme, October 9, 2008 See: http://www.economist.com/world/asia/displaystory.cfm?story_id=12376698.

Ruixiang, Zhu. "China's South-North Water Transfer Project and Its Impacts on Economic and Social Development." Management Bureau of South-North Water Transfer Planning and Design. Ministry of Water Resources. See: http://www.mwr.gov.cn/english1?20060110104100XDENTE.pdf.

Water quality risks are often overlooked but may have significant financial implications. The quality of process water is critical in many industrial production systems, and contaminated water supply may require additional investment and operational costs for pre-treatment. In cases where current high quality source water precludes the need for pre-treatment, degradation of supply can necessitate costly capital expenditures for treatment technology. When alternative source water or treatment options are not physically or financially feasible, facility operations will be disrupted or require relocation. Industrial expansion may also be affected in regions where the water supply is already contaminated.

Water scarcity directly affects power generation, putting some businesses at risk. Water shortages can curtail hydro-based power production, and by extension, businesses that rely on those power sources. Hydropower yields in both the Colorado River and the Great Lakes are expected to decrease significantly.[33] Brazil, a major recipient of foreign direct investment, generates over 90 percent of its electricity from hydropower, and its businesses and domestic economy have already been severely affected by drought-induced reductions in energy production (**see Box 3**). More generally, areas that disproportionately rely upon hydroelectricity for energy (or lack energy diversity in general) can present particular risks. Power plants that run steam turbines, whether fired by coal, natural gas, or nuclear energy, are dependent on an adequate supply of cooling water.

33. Brent M. Lofgren et al., "Evaluation of Potential Impacts on Great Lakes Water Resources Based on Climate Scenarios of Two GCMs" Journal of Great Lakes Research 28, no. 4 (2002): 537-554; Niklas S. Christiansen et al., "The Effects of Climate Change on the Hydrology and Water Resources of the Colorado River Basin," Climatic Change 62, no. 1-3 (January 2004): 337-363.

Box 3. Hydropower reliance in Brazil

In 2001, energy production in São Paulo, Brazil was highly constrained as a result of both severe drought and government energy tariff policies that favored the development of hydroelectric systems over thermal plants. In order to prevent blackouts, the government imposed quotas aimed at reducing energy consumption by 10-35 percent, based on the added value of particular industries and the number of jobs affected. Private electric companies were hard hit by the reduction quotas, including the hydroelectric company AES Tiete, which had closed a US$300 million 15-year bond offering the year before. While the company scaled back costs in order to pay dividends, the effects of the rationing were so severe that the bond payment schedule had to be postponed and ultimately renegotiated. Many other industries based in Brazil's southeast (which accounts for almost 60 percent of the country's GDP) were plagued by reductions in operational capacity, production delays or increased production costs. The effects of the drought-induced energy rationing extended to the national economy, with an estimated reduction of two percent of the country's GDP, or a loss of around US$20 billion.

Source: "Remaining drops: Freshwater resources: A global issue," CLSA U, Pacific Institute and Bio Economic Research Associates, January 2006. See: http://www.pacinst.org/reports/remaining_drops/CLSA_U_remaining_drops.pdf

2.2 Reputational Risks

Physical water resource constraints make companies more susceptible to reputational risks.

Declines in water availability and quality can increase competition for clean water. In water-scarce regions, tensions can arise between businesses and local communities, particularly in developing countries where local populations often lack access to safe and reliable drinking water. Community opposition to industrial water withdrawals and perceived or real inequities in use can emerge quickly and affect businesses profoundly. Local conflicts can damage brand image, or, in rare instances, even result in the loss of companies' license to operate. In Kerala, India, for example, both PepsiCo and Coca-Cola's bottlers lost their licenses to use groundwater, after drought spurred community dissention and increased competition for local aquifers.

Box 4. U.S. water bottling plants face stiff opposition

Water bottling plants proposed by Nestlé subsidiaries, the Perrier Group and Nestlé Waters, have sparked vigorous community protests in Michigan and California. Residents have opposed the companies' plans to withdraw hundreds of millions of gallons of water annually from their local water supplies.

In Michigan, citizens formed Michigan Citizens for Water Conservation and filed a lawsuit arguing that water, like air, is a common resource that is held in public trust and should be managed for the public's benefit. Local politicians in Mecosta, MI aligned themselves with the coalition, giving the protests large media exposure. In the end, legal authorities ruled in favor of the company, finding that the coalition was unable to show that Nestlé's use of Mecosta's groundwater was "unreasonable" under state law; nonetheless, the company suffered significant reputational damage as a result of the negative media attention.

In California, Nestlé Waters signed a contract in 2003 with local government officials allowing the company to build the country's largest bottling plant – a one million square foot facility – at the base of Mount Shasta in McCloud, CA. The deal was supposed to create 240 jobs and bring $350,000 annually to the small town in northern California. Although Nestlé Waters had hoped to begin operations in 2006, the company has been faced with unexpected and sustained opposition. Nearly half of McCloud's 1,300 residents have provided resistance and are demanding the company resubmit its environmental permit application and carry out new environmental impact studies. As of January 2009, Nestlé Waters had not yet secured a contract to build the proposed bottling facilities.

Sources: Tom Henry, "Ideas to improve shipping worry environmentalists: Great Lakes plan dredges up fears," Toledo Blade, October 22, 2002. See: http://www.greatlakesdirectory.org/zarticles/102202_great_lakes2.htm

Michelle Conlin, "A Town Torn Apart by Nestlé: How a deal for a bottled water plant set off neighbor against neighbor in struggling McCloud, Calif.," Business Week, April 16, 2008. See: http://www.businessweek.com/magazine/content/08_15/b4079042498703.htm

As public interest in the impacts of water withdrawal and wastewater discharge on ecosystems and local communities grows, companies' water practices are subjected to greater scrutiny. Major media outlets now routinely cover water-related protests and controversies (**see Box 4**). For instance, the recent discovery that Starbucks' 10,000 coffee shops worldwide have been "wasting" 23.4 million liters of water daily (enough to fill an Olympic swimming pool every 83 minutes) as a result of the company's "open tap" or "dipper well" policy, has generated a significant amount of negative media attention and public criticism.[34] Despite Starbucks' claims that the use of the dipper wells reduces bacteria growth in the taps, making the water safer, the company continues to receive negative media coverage on the issue.

Reputational risks increase as people become more aware of their rights to access water. The concept of "access to clean water as a human right" is gaining more recognition globally (**see Box 5**), yet the failure of governments to provide 100 percent coverage for water services means that international and local businesses may find themselves using copious amounts of water in regions where people lack sufficient water to meet basic needs.

Growing awareness around the ecological impacts of water withdrawal and discharge increases both reputational and regulatory risks. Healthy aquatic ecosystems are an essential part of local communities and livelihoods, not only by serving as a source of clean drinking water, but also by providing cultural, social, aesthetic and economic value. As a result, significant water withdrawal or wastewater discharge, regardless of the extent of actual impacts on the neighboring communities or ecosystems, inevitably increase the risk of potential conflict with local communities. Further reputational risks occur when corporate activities are seen as inconsistent with responsible stewardship. As awareness of the environmental consequences of human water use grows, so do government efforts to reapportion water allotments to support ecosystem functions.

34. "Starbucks denies it wastes water," BBC News, October 6, 2008.
See: http://news.bbc.co.uk/2/hi/business/7654691.stm; Andrea James, "Starbucks lands in hot water."
Seattle Post-Intelligencer, October 9, 2008.
See: http://seattlepi.nwsource.com/business/382648_starbucks10.html

Box 5. The human right to water

The right to water is receiving increasing attention and recognition by human rights and anti-poverty advocates globally. Proponents argue that the realization of the right to water is indispensable to the realization of many other internationally recognized human rights, including the right to food, the right to health, and the right to adequate housing.

To date, the right to water has been recognized in a number of non-binding UN resolutions and declarations, the most important of these being the 2002 General Comment #15 by the UN Committee on Economic, Social and Cultural Rights, which defines the human right to water as "entitl[ing] everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses." However, advocates have highlighted the need for a binding UN convention or treaty on the human right to water that would inscribe this right in international law as both a human right and a public trust. Although the right to water is not yet officially recognized as a human right in international law, a growing number of national governments in the developing world – including South Africa, Uruguay, and Ecuador – have enshrined this right in their constitutions.

For companies, especially those that share or compete for water access with local stakeholders, the human right to water represents an important emerging issue. Investors are increasingly weighing in, and in 2008 companies including PepsiCo, Intel and AIG received shareholder resolutions asking them to endorse the human right to water.

Sources: World Water Council, "The Right to Water, a human right," See: http://www.worldwatercouncil.org/index.php?id=1748

Maude Barlow. Blue Covenant: The Global Water Crisis and the Coming Battle for the Right to Water, New York: The New York Press: 2007.

ICCR's Ethvest Database. www.iccr.org

2.3 Regulatory Risks

Physical and reputational pressures affecting water availability and wastewater discharge can result in more stringent water policies. Water scarcity, coupled with increased concern among local communities about water withdrawals, will put pressure on local authorities and policymakers to consider water reallocations, regulations, and development of water markets that cap usage, suspend permits to draw water and lead to stricter water quality standards. Jurisdictional legal disputes can also arise (**see Box 6**). For example, a century's worth of intense agricultural demand for the water from California's San Joaquin River has virtually dewatered a 60-mile stretch of river and decimated both spring and fall runs of salmon. Following a court ruling against Central Valley farmers by the San Joaquin Valley court, minimum instream flows in the river have been restored at the expense of reduced agricultural diversions.[35] All of these trends create potential risks for large-scale water users whose historical access to water can be turned upside down by policy shifts and legal rulings.

Concerns over water pollution and its impacts on ecosystems and local water resources may lead to new and costly requirements on companies' wastewater discharges. Some national governments already impose strict water quality standards for water supply and wastewater discharge. Such standards can lead to costly litigation, civil penalties or criminal fines.[36] Other governments, especially in emerging markets, have yet to develop and/or enforce water quality standards. However, this is likely to change as economic development continues in these countries and per capita income rises, forcing companies to absorb

35. "2006 Award Winners – California Water Policy 16," California Water Policy Conference 18: Crisis = Opportunity, a Project of Public Officials for Water and Environmental Reform (POWER). See: http://www.cawaterpolicy.org/awards2006.htm

36. For example, in 2008, Massey Energy entered into a $20 million settlement with EPA relating to Clean Water Act violations.

the compliance costs associated with meeting increasingly stringent requirements. For instance, China's Five-Year Plan for 2006–2010 requires that the total volume of certain pollutants be decreased by 10 percent, and water usage by industry be decreased by 30 percent by 2010.[37]

Box 6. Southeast U.S. drought fuels interstate battles

The recent multi-year drought in the southeastern U.S. has had staggering economic and political consequences, pitting the states against each other in a battle over scarce water resources. Regional losses to major field crops, for example, totaled more than $1.3 billion in 2007, according to estimates by the National Drought Mitigation Center at the University of Nebraska.

But the political consequences were more profound. In March 2008, two Georgia legislators introduced a bill to move the state's northern border one mile into Tennessee to correct an 1818 surveyor's error. The move was a thinly veiled attempt to access the resources of the Tennessee River, and it ignited a bitter exchange over water and land rights between the states.

In 2007, South Carolina sued North Carolina over a plan by the North Carolina cities of Concord and Kannapolis to withdraw 10 million gallons a day from the Catawba River. The suit is pending in the U.S. Supreme Court. And Alabama and Florida successfully sued Georgia over a state plan for withdrawing water from Lake Lanier, the main source of drinking water for the Atlanta metro region. Lake Lanier feeds the Chattahoochee River, which supplies water to towns in Alabama and Florida and whose flow is key to the survival of a host of endangered species such as freshwater mussels and sturgeon. The three states have feuded since 1989 over how to divide the water, but the recent drought has exacerbated the problem.

Florida finally took the unusual step in June 2008 of suing the U.S. Army Corps of Engineers over the Army Corps' plans to reduce water flows from reservoirs in Georgia into the Apalachicola River, which runs through Florida from the Georgia-Alabama border. The Apalachicola River discharges its nutrient-rich freshwater into the Apalachicola Bay, and the amount, timing and duration of its flow are key determinants of the bay's biological productivity. Oysters are the bay's hallmark species and they are especially sensitive to the flow of freshwater into the estuary. The total value of Apalachicola Bay's commercial fishing industry is $134 million. A ruling on the lawsuit is expected in spring 2009.

Sources: John Manuel, "Drought in the Southeast: Lessons for Water Management," Environmental Health Perspectives 116, no. 4, April 2008. See: http://www.ehponline.org/members/2008/116-4/spheres.html

Larry Copeland, "Drought spreading in Southeast," USA Today, February 12, 2008. See: http://www.usatoday.com/weather/drought/2008-02-11-drought_N.htm

Water scarcity will increase water prices. Water scarcity is driving shifts toward full-cost pricing aimed at providing economic incentives for efficient water use. In many places, artificially low water prices are rising as subsidies are phased out. In the United States, water prices are increasing to cover the full cost of operating and maintaining water delivery systems such as storage and treatment. In California, for example, the Metropolitan Water District, Southern California's largest wholesale water supplier, raised its price for water by over 14 percent effective January 1, 2009.[38] Where the cost of water is a very minor fraction of the overall cost of production, such price increases alone may have little impact on large-scale enterprises. In other circumstances, price increases may adversely affect profit margins for water-intensive industries, or sectors that rely on water-intensive raw material inputs, such as the food and beverage industries.

37. U.S. Department of Commerce, "Waste and Wastewater Treatment – China," Asia Now. See: http://www.buyusa.gov/asianow/cwater.html

38. Bradley J. Fikes, "Met price hike to float local water rate increases." North County Times, March 15, 2008. See: http://www.nctimes.com/articles/2008/03/16/business/news/8_48_983_15_08.txt

Box 7. U.S. Coastal cities from Massachusetts to Florida see water supplies threatened by climate change

As sea levels rise due to climate change, coastal communities could lose up to 50 percent or more of their freshwater supplies. Saltwater intrusion of freshwater aquifers is an especially big threat to drinking water supplies along the U.S. eastern seaboard, a situation driven by the rapid population growth and over-pumping of groundwater in coastal communities – and exacerbated by rising sea levels.

Across much of Florida, including Miami, the underground freshwater supply is threatened by a combination of over-withdrawal and saltwater intrusion. The Biscayne Aquifer that supplies the majority of South Florida (Miami-Dade, Monroe, and parts of Broward Counties) is primarily recharged by freshwater from the Everglades. Sea level rise could lead to saltwater flooding in parts of the Everglades, threatening both that ecosystem and the aquifer that lies beneath it. Given expectations of local sea level rise of as much as 18 inches by 2050, Miami-Dade officials now estimate that it will cost the county at least $1.9 billion over the next 20 years to maintain the supply and quality of area drinking water.

The U.S. Geological Survey cites Cape Cod as a coastal region particularly susceptible to the impacts of rising sea levels and excessive water use. The summer tourist hub has been designated as having a "sole source aquifer" by the EPA, meaning that as the region's only drinking water source, saltwater contamination or over-pumping would create a significant hazard to public health.

In South Carolina, the water utility for Hilton Head Island, a popular tourist destination and golfing resort, has been forced to abandon eight of the island's 12 supply wells since 1990 due to saltwater intrusion. To ensure adequate drinking supply, local officials are developing a desalinization facility at a cost of approximately $6 million.

Sources: John P. Masterson and John W. Portnoy, "Potential Changes in Ground-Water Flow and their Effects on the Ecology and Water Resources of the Cape Cod National Seashore, Massachusetts," U.S. Geological Survey, General Information Product 13, June 2005. See: http://pubs.usgs.gov/gip/2005/13/index4.htm

Tatiana Borisova, Norman Breuer and Roy Carriker, "Economic Impacts of Climate Change on Florida: Estimates from Two Studies," University of Florida, IFAS Extension, December 2008. See: http://edis.ifas.ufl.edu/pdffiles/FE/FE78700.pdf

Michael Miller, "Good and bad news ahead 'On the Waterfront,'" Miami's Community Newspapers, December 22, 2008. See: http://www.communitynewspapers.com/html/index.php?option=com_content&task=view&id=2361&Itemid=51

Water-intensive products and services face increased socio-political risks. As water scarcity becomes a serious problem in many parts of the world, there may be corollary pressure, both regulatory and reputational, on products that require a significant quantity of water. Products and services that require large amounts of water to produce or to use may be phased out by law, lose market share to less water-intensive products, or may lead to reputational damage for the company. The U.S., European Union, and Australia have all passed legislation banning the use of energy-intensive incandescent light bulbs,[39] and such energy legislation suggests that governments worldwide may look to adopt similar product bans to reduce water consumption as scarcity concerns grow. This is already occurring in places like California, which adopted legislation in 2007 requiring all toilets sold within the state to use no more than 1.6 gallons per flush and urinal and associated

39. "Congress bans incandescent bulbs: Massive energy bill phases out Edison's invention by 2014," World Net Daily, December 19, 2007. See: http://www.worldnetdaily.com/news/article.asp?ARTICLE_ID=59298; Louise Gray, "Traditional light bulbs banned by EU: Traditional light bulbs are to be banned from 2010, EU energy ministers have decided," Telegraph, October 10, 2008. See: http://www.telegraph.co.uk/news/worldnews/europe/3174452/Traditional-lightbulbs-banned-by-EU.html; "Australia pulls plug on old bulbs," BBC News, February 20, 2007. See: http://news.bbc.co.uk/2/hi/asia-p0, acific/6378161.stm

flushometer valves to use no more than one gallon per flush by 2014.[40] New York City and the state of Texas are currently considering similar legislation.[41]

Water stress increases political and economic instability. Water issues are inherently political as well; nearly every major river system on the planet is shared by two or more nations, making water resources a frequent cause of tension between nations or competing jurisdictions within nations (as discussed in the southeastern U.S. example – **Box 6**). As such, water scarcity threatens political stability as much as it does economic development (**see Box 8**). The threat of war or other political disruption in regions where companies operate or have source inputs is both a humanitarian concern and a significant threat to corporate operations that rely on the resources at the root of the conflict.

Box 8. China, Tibet, and the strategic power of water

The long-standing conflict between China and the Tibetan Government in Exile is well-known throughout the world; however, few are aware of the growing water scarcity issues in the Tibetan Plateau that are exacerbating the already tumultuous politics in the region. The Tibetan Plateau in western China holds the headwaters of many of the world's largest rivers, including the Yellow, Yangtze and Mekong. Nearly two billion people in China and other neighboring countries rely on these water resources originating in the Plateau, a region that has traditionally had a greater water storage capacity than any place in the world, excluding the poles. However, recent studies by the Chinese Academy of Sciences and the Intergovernmental Panel on Climate Change (IPCC) suggest that increased industrial activities in the region, most notably logging, mining, and manufacturing, are severely affecting water quality, while climate change is hastening glacial melt and threatening water access and long-term supplies.

These concerns significantly increase the risk of heightened political conflict and instability. China already considers water to be a crucial strategic asset. The depletion of its most importance source of water will only enflame conflict between itself and many of the region's inhabitants. Furthermore, water scarcity will bring to the forefront looming concerns and potential conflict over water allocations between China and the governments of neighboring nations, such as India, Bangladesh, Vietnam, Cambodia, Thailand, Laos and Burma, which also rely heavily on water resources originating in Tibet.

Source: Keith Schneider and C.T. Pope, "China, Tibet, and the strategic power of water," Circle of Blue: WaterNews, May 8, 2008. See: http//www.circleofblue.org/waternews/world/china-tibet-and-the-strategic-power-of-water/

40. "California Adopts New Toilet Standards: Flush volume of fixtures to be reduced by 2014," Alliance for Water Efficiency, November 15, 2007. See: http://www.allianceforwaterefficiency.org/news/California_Adopts_New_Toilet_Standards.aspx: State of California, "Assembly Bill No. 715." Chapter 499, October 11, 2007. See: http://www.allianceforwaterefficiency.org/WorkArea/showcontent.aspx?id=372
41. Ibid.

3. Evaluating Industry Sector Risks

Numerous industry sectors face significant water exposure, although the degree and nature of the risks differ widely. These variations hinge on the distinct "water footprint" of each industry sector, including unique direct and indirect water use and discharge patterns inherent in their respective value chains (**see Box 9**). Below we apply the risk framework (i.e., physical, reputational, and regulatory) to evaluate the water footprints of eight industry sectors: apparel, high-tech/electronics, beverage, food, biotechnology/pharmaceuticals, forest products, metals/mining and electric power/energy.[42] For each of the sectors, we describe key water risks that businesses and investors should consider when determining management and investment strategies. A more detailed water footprint analysis for each sector can be found in **Appendix A**.

Box 9. Measuring a corporate water footprint

In response to growing concerns about water scarcity and unchecked water consumption, corporate water footprinting has emerged as a useful tool for assessing water use and pollution. The simple definition of a water footprint is: "the total volume of freshwater that is used to produce the goods and services produced by the business." Water footprinting has dual benefits: in addition to determining a company's basic water use, it can provide a standard for comparing and benchmarking water use with industry peers.

Water footprinting is geographically explicit, indicating the location of water withdrawal or discharge, and includes both direct (e.g. water withdrawals) and indirect water use (e.g. the water used to produce inputs). A water footprint measures three primary components: blue, green and gray water footprints. Blue water is freshwater from surface water and groundwater sources. Green water is rainwater stored in the soil as soil moisture, and gray water is polluted water.

The water footprinting methodology is being continually developed, disseminated, and supported by the Water Footprint Network (WFN), which has grown out of the work of the closely-tied Water Footprint Working Group (WFWG), discussed in more detail in **Appendix C**.

Source: "Water Footprint," Water Footprint Network, "Water Footprint, 2008." See: http://www.waterfootprint.org/?page=files/DefinitionWaterFootprint

Table 3 uses generic value chain segments – raw material production, suppliers, direct operations and product use/end of life – to illustrate relative differences in water footprints. It should be noted at the outset that individual companies' water risks are not necessarily directly proportional to quantities of water used or discharged (i.e., water footprint intensity), but instead are influenced by a multitude of factors, such as:

- Location of water withdrawal/discharge and natural and socio-economic environment of that region;

42. The sectors have been defined using the Industry Classification Benchmark (ICB) developed jointly by Dow Jones and FTSE. Their ICB codes are:
    1. Apparel – Clothing & Accessories [3763], Apparel Retailers [5371]
    2. High-Tech/Electronics – Technology Hardware & Equipment [9570]
    3. Beverage – Beverages [3530]
    4. Food – Food Products [3577]
    5. Biotechnology/Pharmaceuticals – Pharmaceuticals & Biotechnology [4570]
    6. Forest Products – Forestry & Paper [1730]
    7. Metals/Mining – Industrial Metals & Mining [1750], Mining [1770]
    8. Electric Utility/Energy – Electricity [7530]

    For the full ICB structure, see: http://icbenchmark.com/docs/ICB_StructureSheet_200803.pdf

- Quality of water required, timing or reliability of water supply necessary for certain processes/sectors;
- Climate change impacts and energy implications of water use/discharge.

Still, a large water footprint in a particular segment of a sector's value chain is usually a good proxy for increased overall risk as well as business opportunity.

Table 3. Relative Water Footprint of Various Industry Sectors

	Raw material production	Suppliers	Direct operations	Product use/ end of life
Apparel				
High-Tech/ Electronics				
Beverage				
Food				
Biotech/Pharma				
Forest Products				
Metals/Mining				
Electric Power/ Energy				

Water drops indicate the value chain segments that have relatively high blue, green and gray water footprint intensities.

3.1 Cross-Sectoral Conclusions

Our analysis of these eight sectors reveals some general trends:

Value chain impact is larger than operations

For most industry sectors, the largest portion of their water footprint is embedded in the production of raw materials such as food crops, fibers and metals. Many companies' raw material production lies far upstream from direct operations; as a result they typically fail to assess water-related risks in this segment of their value chains. Nevertheless, severe drought, flooding or changes in precipitation patterns due to climate change can decrease agricultural yields and quality, which may increase input costs. In addition, water scarcity and increased competition for freshwater resources can change pricing structures or subsidies for irrigation water for crop or livestock production, which can also drive up costs.

In some sectors (e.g., high-tech/electronics and apparel), the bulk of the water footprint is associated with the manufacturing activities of suppliers. This can lead to a false sense of security about water risk exposure, with companies dismissing water issues as not being material to their business. For example, Dell and HP, which together represent 55 percent of the U.S. PC market,[43] both fail to acknowledge in sustainability reports or security filings

43. IDC. "PC Market Growth Evaporates in Fourth Quarter as Financial Crisis Hits Home," IDC Press Release, January 14, 2009. See: http://www.idc.com/getdoc.jsp;jsessionid=K1NIFLRTPR1R4CQJAFICFGAKBEAUMIWD?containerId=prUS21627609

that semiconductors – a crucial supply chain component of their products – require a large amount of clean water to manufacture.

Increasing competition with local populations for water access

Industries requiring high quality source water (i.e., beverage, food, high-tech/electronics, and biotech/pharmaceutical) face increased risk because their water needs can be in direct competition with local populations. Large water withdrawals can result in reputational damage in regions where water is scarce and/or local populations lack access to safe and affordable drinking water. In cases of severe scarcity, shortage, or contamination of water sources, manufacturing facilities risk shutdown or relocation. Increasing water scarcity is also expected to generally worsen water quality, increasing water pre-treatment costs.

Wastewater discharge poses growing risk

Sectors such as food, biotech/pharmaceutical, forest products, metals/mining, and electric power/energy face a multitude of risks associated with their gray water footprint (i.e. large volume/high concentration wastewater discharges). Because of the high volume and concentration of chemicals in wastewater created in these sectors' manufacturing processes, reputational and regulatory risks of spills into freshwater resources and surrounding communities and ecosystems can be very high. New or more stringent wastewater regulations may increase costs for wastewater treatment and discharge, disproportionately affecting these sectors.

3.2 Sector-by-Sector Analysis of Various Water Risks

Apparel

Cotton production is the most water-intensive value chain segment for the apparel sector and is also the segment most vulnerable to climate-induced physical water risks. Cotton is a hugely thirsty plant requiring 25 cubic meters of water for each 250 grams of cotton produced – the amount needed for the average T-shirt.[44] Typically, cotton is grown in arid, but intensely irrigated regions, such as California's San Joaquin Valley, Egypt, Pakistan and Uzbekistan. In the case of Uzbekistan, the world's second largest cotton exporter, the extraction of water from rivers flowing to the Aral Sea to irrigate millions of acres of cotton is a key cause of the ecologically disastrous shrinkage of that Central Asian sea and its conversion to desert.[45]

Wastewater/water quality issues in cotton production are often disregarded by apparel companies, but present reputational and regulatory risks. Agricultural run-off containing agro-chemicals (e.g. fertilizer, herbicide, insecticide, etc.) can pose significant impacts on local ecosystems and drinking water sources. Moreover, climate change may increase the amount of chemical inputs needed for cotton growing. Despite these risks, many apparel manufacturers and retailers consider cotton production outside their sphere of influence, and thus are not prepared to address them proactively.

44. Valerie Stevens, "Fresh Water," Optimum Population Trust, Manchester, United Kingdom, March 5, 2007. See: http://www.optimumpopulation.org/opt.more.water.html

45. Ibid.

Textile processing, which is both water- and energy-intensive, also presents physical risks. Freshwater is an essential resource for textile processing such as dyeing or bleaching. Yet, a large percentage of textile/garment manufacturing operations are located in water-scarce regions such as Southeast Asia, India and other areas where local communities lack access to reliable and affordable drinking water.[46] These regions are also most susceptible to climate change impacts on water resources. Furthermore, water used for textile processing often requires heating and consumes large amounts of energy.

High-Tech/Electronics

Water is an important resource for the high-tech industry, with the most significant portion of the industry's water footprint associated with semiconductor manufacturing. Intel and Texas Instruments alone used more than 11 billion gallons of ultra-pure water for cleaning and rinsing in the production of silicon chips in 2007.[47] Reliability of water supplies is an important risk factor for these companies. A JPMorgan study estimates that a water-related shutdown at a fabrication facility operated by Intel or Texas Instruments could result in $100–$200 million in lost revenue during a quarter, or $0.02 or $0.04 per share, depending on what products are being made.[48]

Offshore production in particular faces increased water risk. Information technology (IT) firms face some water-related exposure in the U.S., but a potentially larger source of risk is in Asian and Pacific Rim countries, where water resources are already under stress due to rapid population and economic growth, and where IT manufacturing facilities are increasingly moving. Currently, 11 of the top 14 integrated circuit foundries in the world are located in the Asia-Pacific region, accounting for over 75 percent of the industry's sales.[49]

Electronic waste (e-waste) can cause extensive contamination of groundwater resources and local ecosystems, which, in turn, can lead to health concerns, regulatory controls, and adverse reputational impacts. According to the NGO watchdog group the Silicon Valley Toxics Coalition, e-waste is concentrated with heavy metals, such as chromium, zinc, lead, copper, manganese, selenium, and arsenic that leach into groundwater sources more than other municipal solid wastes.[50] The NGO warns that the threat of groundwater contamination from e-waste will only increase as the volume of e-waste in landfills continues to grow.

46. Liz Muller, Heather Cooley and Mari Morikawa, Patrick Neyts. "Building resiliency: the intersection of business and community responses to climate change in the cotton apparel supply chain." A research paper prepared for Oxfam America. June 16, 2008.
47. Marc Levinson et al., "Watching water: A guide to evaluating corporate risks in a thirsty world," JPMorgan Global Equity Research, March 31, 2008.
48. Ibid.
49. Ann Steffora Mutschler, "Pure-play foundries comprise 84% of market, IC Insights says," Semiconductor International, May 9, 2008. See: http://www.semiconductor.net/article/CA6559384.html?q=asia+outsourcing
50. Mark Clayton, "Tackling 'e-waste,'" The Washington Times, January 14, 2004. See: http://www.etoxics.org/site/PageServer?pagename=svtc_washtimes_1_14_2004

Beverage

Potable water is the primary and most important ingredient for the majority of beverage products, making beverage companies' direct operations especially vulnerable to water availability and quality concerns. Beverage manufacturing requires high quality source water, putting the water use of this industry in direct competition with local populations and their drinking water needs. Large water withdrawals can result in controversies in regions where water is scarce and local populations lack access to affordable drinking water. In cases of severe shortages or contamination of drinking sources, bottling and manufacturing facilities risk shutdowns, as PepsiCo and Coca-Cola bottlers experienced in Kerala, India.

Public concern about clean water access is impacting bottled water sales, worth $91 billion globally in 2007. Consumer demand is soaring in developing countries, but falling in large developed countries such as the United States. PepsiCo sustained lower quarterly earnings and major job losses in 2008, largely due to falling sales of its non-carbonated beverages and bottled water.[51] A 2008 Morgan Stanley study showed that 16 percent of consumers are cutting back on bottled beverages and drinking more tap water for environmental reasons.[52]

Food

Water plays a fundamental role in the food industry. Roughly 70 percent of the water used globally is for agriculture, with as much as 90 percent of water dedicated to agriculture in developing countries. JPMorgan estimates that the total annual direct use of five of the world's biggest food and beverage companies (Nestlé, Unilever, Kraft, Danone and Coca-Cola) represents about 600 billion liters – or 95 liters for every person on the planet in 2006.[53]

The industry's most significant water-related exposure is in raw material production (i.e., precipitation and irrigation needed to grow food and maintain pasture land for grazing). Many of the world's croplands are in semi-arid areas that are expected to become drier due to climate change. Among the regions at risk is the High Plains (or Ogallala) aquifer that provides water for 27 percent of the irrigated land in the U.S. and 70 to 90 percent of the irrigation water for three of the country's top producing grain states – Texas, Kansas and Nebraska. Human-induced stresses on the aquifer have already resulted in water table declines greater than 100 feet in some areas. "This already difficult situation could be greatly exacerbated by a decrease in rainfall predicted in the region," concludes a 2007 study.[54]

51. Andrew Martin, "Tap water's popularity forces Pepsi to cut jobs," International Herald Tribune, October 15, 2008. See: http://www.iht.com/articles/2008/10/15/business/15pepsi.php
52. William Pecoriello and Brett Cooper, "Beverages: Environmental Concerns Present a Structural Challenge for the Industry," Morgan Stanley, Morgan Stanley Research, June 12, 2008.
53. Marc Levinson et al., "Watching water: A guide to evaluating corporate risks in a thirsty world," JPMorgan Global Equity Research, March 31, 2008.
54. "National Security and the Threat of Climate Change," The CNA Corporation, Virginia, 2007. See: http://securityandclimate.cna.org/report/

Water availability also impacts food commodity prices, as was shown in summer 2008 when a drought-induced collapse of rice production in Australia helped trigger a sharp increase in global rice prices, impacting food security in import-dependent countries in the Middle East and Caribbean.[55] The multi-year Australian drought has also devastated the country's wheat crop, leading to a 42 percent spike in the price of a ton of Australian wheat in 2008 compared with early 2007 prices.[56]

Increased temperature and dry weather due to climate change will raise water requirements for livestock whose numbers are growing as global demand for meat increases. Consumption of red meat in large developing countries like India and China has risen 33 percent in the last decade and is expected to double globally between 2000 and 2050.[57] As recognition grows among consumers that meat is a very water-intensive food with a large carbon footprint, it may affect demand for meat products. As water problems become more severe, the impacts of agriculture generally will draw even more attention.

The growth and intensity of global agricultural practices have a significant impact on water quality. Eutrophication—the over-enrichment of water by fertilizers such as nitrogen and phosphorus—can lead to aquatic "dead zones" characterized by oxygen depletion and harmful algal blooms. The World Resources Institute recently mapped the world's dead zones and found 415 eutrophic zones.[58] In the United States, the discharge of nutrients from midwestern farms into the Mississippi River has been linked to an aquatic dead zone in the Gulf of Mexico the size of New Jersey.

Higher water temperature due to climate change may increase the concentration and variety of water-borne pathogens. As a result, food supplies may face greater risk of contamination and recall, disrupting the supply of ingredients for food manufacturers and negatively affecting consumer confidence in food products.

Biotechnology/Pharmaceuticals

Growing concern about the persistence of some pharmaceutical products and their impacts on water sources and ecosystems presents both regulatory and reputational risks. These chemicals and microbial organisms, which are discharged into the environment through product disposal or human and animal waste, can pose environmental health concerns even at trace levels.

Because of the high concentration of chemicals and microbial organisms in wastewater released in manufacturing processes, leaks into natural water resources and surrounding ecosystems can be quite harmful. Such spills can severely damage companies' reputation and brand image. For example, in 2007 pharmaceutical giant Merck agreed to pay $20 million in assorted fines, environmental improvements and cleanup costs as a consequence of polluting Wissahickon Creek in Pennsylvania with a chemical discharge that resulted in fish kills and fouled drinking water supplies.[59]

55. Carolyn Barry, "Australia's Long Drought Withering Wheat, Rice Supplies," *National Geographic News*, May 29, 2008. See: http://news.nationalgeographic.com/news/2008/05/080529-food-australia.html
56. Tanalee Smith, "Food crisis: Drought hurts vital Australian wheat," USA Today, July 13, 2008. See: http://www.usatoday.com/news/world/2008-07-13-294300987_x.htm
57. Elizabeth Rosenthal, "As more eat meat, bid to reduce emissions," *The New York Times*, December 3, 2009. See: http://www.nytimes.com/2008/12/04/science/earth/04meat.html
58. Dan Shapley, "Ethanol, Global Warming and the Ailing Gulf," *The Daily Green*, July 15, 2008. See: http://www.thedailygreen.com/environmental-news/latest/gulf-dead-zone-47071506
59. Sandy Bauers, "Fish kill to cost Merck more than $20 million: Environmental projects, fines and plant improvements are set," *Philadelphia Inquirer*, December 14, 2007.

Forest Products

The forest products sector is particularly susceptible to scarcity-induced disruptions or increased costs for water and/or energy supplies because it is very water- and energy-intensive, especially in pulp and paper manufacturing. In the United States, for instance, the forest products sector is the third-largest water user among industrial manufacturers.[60] Pulp and paper manufacturing is also the third-largest consumer of fossil energy among U.S. manufacturing sectors, representing 12 percent of total energy consumption by U.S. manufacturing industries in 2002.

Paper and pulp manufacturing also produces a significant amount of wastewater. Community opposition to the water impacts of pulp mills is evident in many places, including Argentina. There, a dispute over the construction of two pulp mills (one by Finnish company Botnia and the other by the Spanish firm ENCE) on a river that serves as a natural border between Argentina and Uruguay culminated in massive demonstrations by citizens and environmental activists, who contended that the pulp mill would pollute the Uruguay River and harm nearby soybean and citrus plantations. The dispute took the two countries to the International Court of Justice in The Hague in 2006, significantly delayed the construction of both mills, and caused one to be relocated.[61]

The sector is particularly at risk for climate change-induced supply chain impacts. Climate change will increase the risk of forest fires, due to increased temperatures, droughts and water shortages for firefighting. Changes in precipitation patterns will negatively affect forest growth, requiring more extensive and costly forest management activities.

Forests are key components of watersheds and ecosystems that influence water supply and quality. Accordingly, planting, harvesting and logging operations have significant impacts on local water resources, which may lead to conflicts with local communities, and/or damage companies' reputation and brand image.

Metals/Mining

The mining sector's reliance on high volumes of water makes it quite vulnerable to water scarcity. Mining operations cannot be relocated, making the sector susceptible to changing local water availability and community concerns about water use. Unlike manufacturing sectors, mining operations depend on the location of ore and cannot change their locations to mitigate or adapt to regional water scarcity or water quality impacts. The Canadian miner Barrick Gold, for example, faces intense public opposition from a $1.5 billion project to extract large amounts of gold – at least $11.5 billion worth – from beneath three glaciers in Chile that provide drinking water to local communities.[62]

60. EPA, "Forest Products," 2006. See: www.epa.gov/ispd/pdf/2006/forestproductsbw.pdf

61. "Argentina & Uruguay: Grinding Small," *The Economist*, December 6, 2007.

62. Larry Rohter, "So Much Gold, But Andean Farmers See Big Risks, Too," New York Times, July 30, 2006, See: http://www.nytimes.com/2006/07/30/world/americas/30chile.html?n=Top/News/Business/Companies/Barrick%20Gold%20Corp.

This sector also produces significant amounts of wastewater related to ore mining and refining. For several years Newmont Mining has faced controversy in Peru[63] and Indonesia[64] regarding its use of mercury to leach gold ore, which local groups claim have contaminated water sources and damaged local ecosystems.

Finally, mining operations may be disrupted by severe rain or flooding, and climate change is expected to increase the frequency and severity of such extreme weather events.

Electric Power/Energy

The electric power industry requires a consistent supply of water, and accounts for 39 percent of total freshwater withdrawals in the U.S.[65] Fossil fuel plants and nuclear power plants require about 140 liters and 200 liters of water per kilowatt-hour of electricity produced, respectively.[66] Water scarcity and uncertainty about the reliability of supply due to climate change may have significant impacts on operations (**see Box 10**). In summer 2007, prolonged drought conditions forced the Tennessee Valley Authority to partially shut down its Brown Ferry nuclear plant in Alabama due to the high temperature of the cooling water drawn from the Tennessee River. Furthermore, heated discharges from power plants have a harmful effect on water quality and local ecosystems, which is only exacerbated as water levels drop.

Box 10. Droughts undermine U.S. and European nuclear plants

In 2003, Electricité de France had to shut down a quarter of its 58 nuclear plants due to water shortages caused by a record-setting heat wave. The closures triggered price spikes of 1,300 percent and about €300 million in losses for the French utility. Nuclear plants in the southeastern U.S. faced a similar threat in 2007 when one nuclear plant was partially closed and several others were threatened by drought-induced water shortages. "Water is the nuclear industry's Achilles heel," says Jim Warren, executive director of the North Carolina Waste Awareness and Reduction Network. Nuclear plant closures in the southeastern U.S. would have adverse impacts on businesses due to the higher cost of replacement power. "Currently, nuclear power costs between $5 to $7 to produce a megawatt hour," says Daniele Seitz, an energy analyst with New York-based Dahlman Rose & Co." It would cost 10 times that amount if you had to buy replacement power – especially during the summer."

Sources: Marc Levinson et al., "Watching water: A guide to evaluating corporate risks in a thirsty world," JPMorgan Global Equity Research, March 31, 2008.

Mitch Weiss, "Drought Could Force Nuke-Plant Shutdowns," Associated Press, January 24, 2008. See: http://www.commondreams.org/archive/2008/01/24/6580

63. Jane Perlez, "Gold Mining Company to Pay Indonesia $30 Million," New York Times, February 17, 2008. See: http://query.nytimes.com/gst/fullpage.html?res=9D00EEDF103EF934A25751C0A9609C8B63&sec=&spon=&&scp=4&sq=newmont%20indonesia&st=cse
64. Jane Perlez, "Gold Mining Company to Pay Indonesia $30 Million," New York Times, February 17, 2008. See: http://query.nytimes.com/gst/fullpage.html?res=9D00EEDF103EF934A25751C0A9609C8B63&sec=&spon=&&scp=4&sq=newmont%20indonesia&st=cse
65. "Energy Demands on Water Resources: Report to Congress on the Interdependence of Energy and Water," U.S. Department of Energy, December 2006. See: http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAcomments-FINAL.pdf
66. Ibid.

Hydropower plants are at increased risk due to decreases or changes in water flow caused by climate change. Hydropower generation is likely to be most directly affected by climate change because it is sensitive to the amount, timing and geographical pattern of precipitation and temperature.[67] In parts of the United States such as Alaska and the Rocky Mountains, natural water storage in snowpack and glaciers has been reduced. Climate change may also increase evaporation rates of reservoirs in arid parts of the U.S., such as Lake Mead and Lake Powell on the lower Colorado River.[68]

The sector has significant water-related risks embedded in raw material supply. Extraction and processing of fossil fuels require large volumes of water. Water scarcity or a change in water supply due to climate change may disrupt fuel supply or increase the cost of fuel for power generation (**see Box 11**).

Box 11. Oil sands operations in Canada threaten local rivers

In 2008, water-intensive oil sands production expanded rapidly in northern Alberta, with more than one million barrels of oil being produced each day.[69] Oil sands production, which involves extracting oil from a sticky mud-like substance, has significant water impacts. Oil companies with major investments in Canadian projects include Exxon, BP, ConocoPhillips, Shell and Chevron. Mining and processing of oil sands requires huge amounts of water, much of which ends up as pollution-laden wastewater in tailing ponds that stretch for miles and miles. So toxic are these ponds that birds have literally dropped dead after landing on the water. The projects' growing reliance on Northern Alberta's Athabasca River for source water is another threat. Every barrel of oil extracted requires two to four barrels of water for processing. In the last three decades alone, stream flows have declined 30 percent from the Athabasca River watershed. A study by Dr. David Schindler, a top water expert in Canada, suggests that the lack of available water could limit oil sands expansion in the future. Schindler projects that future oil sands growth, combined with climate change, could reduce the river's low winter flows 50 percent or more by mid-century.

Sources: Shelley Alpern, "Tar Sands Development Stickier Than Anticipated," Trillium Asset Management. See: http://trilliuminvest.com/uncategorized/tar-sands-development-stickier-than-anticipated

Martin Mittelstaedt, "Choke point for oil sands may be water shortage," The Program on Water Issues, Munk Center for International Studies, University of Toronto, Toronto, Canada, May 11, 2007. See: http://www.powi.ca/pdfs/other/choke-point-for-oil-sands-may-be-water-shortage.pdf

67. IPCC "Climate Change Impacts, Adaptation, and Vulnerability," Contributions of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge and New York: Cambridge University Press, 2007. See: http://www.epa.gov/climatechange/effects/energy.html
68. Stanley R. Bull et al., "Effects of Climate Change on Energy Production and Distribution in the United States," The U.S. Climate Change Science Program, (2007): 29-48. See: http://www.climatescience.gov/Library/sap/sap4-5/final-report/sap4-5-final-chap3.pdf
69. While many proposed oil sands projects have temporarily been put on hold due to economic conditions, existing operations remain a significant threat to local water resources.

4. What Companies Can Do to Manage Water Risk

4.1 Corporate Action Plans on Water

Mitigating water-related business risks will require action, both by investors and companies themselves. Companies have a clear economic incentive to closely assess their relationship to their water inputs and outputs and to proactively address and manage them. To do so, companies should take the following steps:

1. Measure the company's water footprint (i.e., water use and wastewater discharge) throughout its value chain.
2. Assess the physical, regulatory and reputational risks associated with its water footprint, and seek to align findings with the company's energy and climate risk assessments.
3. Engage key stakeholders (e.g., local communities, NGOs, government bodies, suppliers, employees) as a part of the water risk assessment, long-term planning and implementation activities.
4. Integrate water issues into strategic business planning and governance.
5. Disclose and communicate water performance and associated risks.

1. Measure water footprint

Some of the most significant water risks can be embedded in a company's value chain, well outside of its direct operations or control. In many cases, a company's direct water use pales in comparison with embedded supply chain impacts. Even if water impacts occur outside of a company's sphere of influence, they can still pose great risks to the company's bottom line or reputation.

In order to accurately assess water risks and opportunities, a first step for companies is to conduct a comprehensive water accounting of direct and indirect water use and wastewater discharge (**see Box 12**). This can be done by using emerging approaches such as the water footprinting methodology discussed previously (**Box 9**), or with simpler approaches such as reviews of water utility invoices for key operations and surveys with key suppliers.[70] Companies should also look to align water footprinting with any energy or carbon footprint analyses already conducted.

70. Companies can also use a full free online risk-mapping tool developed by World Business Council for Sustainable Development. See: www.wbcsd.org/web/watertool.htm

Box 12. SABMiller's water footprint assessment

SABMiller recently conducted a water footprint analysis of its beer production in South Africa, attempting to assess water use across its value chain. The analysis measured the amount of water used in malting production, in manufacturing containers, and to grow barley, concluding that 95-98 percent of SABMiller's water footprint lies within agricultural production. It also calculated the amounts of "green water" (precipitation, plant evapo-transpiration, and soil moisture content), "blue water" (surface and groundwater that is available for irrigation, urban and industrial use and environmental flows), and "gray water" (the volume of polluted water that is associated with the production of all goods and services in factory or plant) used, determining that green water comprises roughly 70 percent of water use. The final analysis estimated that 155 liters of water are used for every liter of SABMiller beer produced, though the company predicts this number may be even higher in reality.

This analysis allowed SABMiller to identify the most strategic points for water conservation, as well as to define strategic questions, such as how to gauge the water impacts of green versus blue water use, how to determine "reasonable share" for green and blue water supplies, and how to best influence the water efficiency of their agricultural suppliers. SABMiller's research concluded that understanding the actual water impacts within the local context (rather than volumetric water use) is one of the primary gaps in current water footprint accounting methodologies.

Sources: "CEO Water Mandate Inaugural Working Conference," Meeting Summary, United Nations Global Compact and Pacific Institute, UN Headquarters, New York City, March 5-6, 2008. See: http://www.unglobalcompact.org/Issues/Environment/CEO_Water_Mandate/2nd_conference_21_08_2008.html;

"Water Footprint," Water Footprint Network, 2008. See: http://www.waterfootprint.org/?page=files/DefinitionWaterFootprint

2. Assess risks

The impacts of companies' water use vary greatly depending on local hydrological, social, economic, and political factors. Unlike greenhouse gas emissions, which have the same impacts regardless of where the emissions are generated, one unit of water is not equal to another: the same amount of water withdrawn in an arid urban area versus a rural wet region has completely different impacts and associated risks for companies. The absolute volume of water used is often less important than the timing of its use. Because of water's regional and timing-specific character, companies need to convert water footprint data into actual water impacts and risks.

This emerging practice includes an analysis of such issues as:

- **Physical risks:** local hydrological conditions (potential shortage risks, water quality risks, flooding risks, and possible impacts of climate change on future water supply and demand);
- **Regulatory risks:** socio-economic conditions as they relate to water (trends in regional demand, local water governance capacity, and regional water pricing) and potential regulatory costs;
- **Reputational risks:** potential impacts of a company's water withdrawal or wastewater discharge on local communities and ecosystems, and disparities or inequities in local and regional water access.

Explicit attention should be paid to understanding energy-related risks posed by water (and vice versa), as well as any potential competing demands the company may have for water and energy. If possible, companies should also seek to align, if not integrate, their water and climate risk assessments. Regardless, having a detailed understanding of local water conditions, including hydrological, social, economic, and political factors, can give companies room to anticipate and plan for a wide range of scenarios.

3. Engage key stakeholders

When developing a corporate water management plan, decision-makers can benefit from sharing information learned with employees, investors, customers, local communities, and other key stakeholders in order to gain valuable feedback. Through early and continuous engagement with concerned stakeholders, companies can better understand, anticipate, and respond to emerging issues and expectations, such as competing water demands by local communities or industries or local concerns over wastewater discharges. Open dialogue with water providers and local communities may also be helpful in preventing and reducing the risk of future water-related disputes or disruptions. Such discussions may also identify pivotal inputs that help prioritize action steps.

4. Integrate water into strategic business planning and corporate governance

Corporate water policy: A corporate water policy is an essential vehicle for guiding decisions throughout a business, and for communicating practices and expectations to suppliers, partners, and other stakeholders. A corporate water policy should include the following:

- A statement on why water is important for the business
- How, and to what degree, company activities impact water resources
- Challenges the business faces in water management.

Water management and governance: To help drive performance, companies should develop water management plans, set goals and targets, and establish high-level executive and board accountability for water risk. Specifically, companies should:

- Affirm top management commitment by clearly articulating the linkages between water-related issues and financial performance.
- Make water management the responsibility of a top executive who reports directly to the CEO and ensure that a board committee has water management issues as a clear part of its mandate.
- Develop a water management program with specific priorities, tasks, measures and quantified performance goals based on the company's water, energy, and carbon footprints and impact assessments.
- Consult water suppliers, industry associations, and regulatory agencies for guidance, best management practices, technical assistance or financial incentives, and information about applicable regulations.
- Form a water-energy team staffed by representatives of every business function that uses significant amounts of energy or water, or that has the potential to pollute water systems.
- Publicize water management objectives to employees and external stakeholders and solicit feedback.
- Provide clear position statements on public policies that impact water issues at the local, state and federal levels.

Integrate water with energy and climate strategic planning: When developing water management plans, companies will need to consider and integrate the potential impacts of climate change on water supplies and water quality. Climate-related impacts on water should also be considered when making a range of strategic business decisions from factory design and siting to new product development. Companies should also evaluate the energy implications of water management plans and strategies and seek combined and integrated solutions to water and energy.

Contingency plans: For key areas of operation and sourcing in high risk regions, contingency plans should be developed to respond to risks such as decreasing water availability and quality, higher water prices, extreme hydrologic events, and local economic development. Potential climate-related impacts should be explicitly considered in contingency plans.

Contingency plans should also include demand-side and supply-side strategies. For example, conservation and efficiency improvement measures or process modifications that reduce or eliminate water use will decrease the company's dependency on freshwater supplies. Supply-side measures include collaboration with local authorities and stakeholders to improve local water security and participation in integrated water management or ecosystem restoration to protect local water sources.

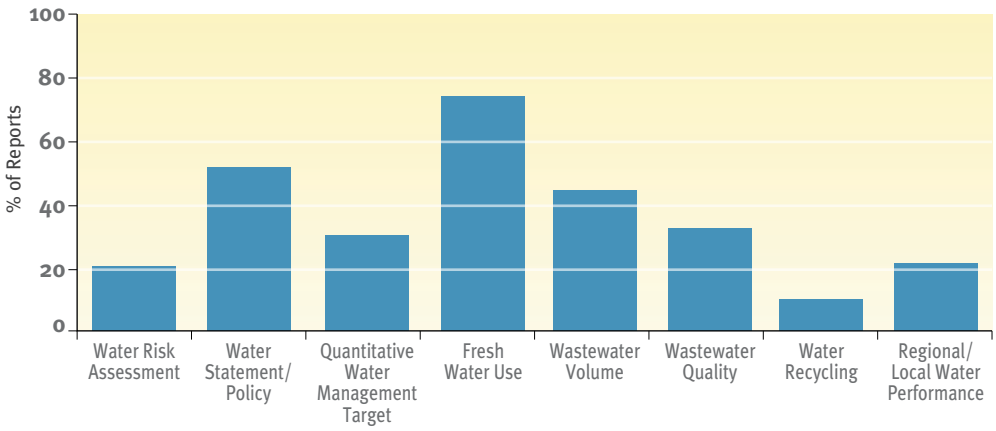
Risk management in companies' value chain: A company's strategic water plan should focus on managing water quality and increasing water efficiency in the processing and sourcing of raw materials and other inputs, as well as water impacts during and after product use. Water risk management should also foster engagement with suppliers, including training and support along the supply chain.

5. Disclose water performance and risks

Companies should publicly report management activities and key metrics on their water use and impacts and track how their performance changes over time. This information can help shareholders and stakeholders assess how companies are addressing their water risks. Such metrics are also a useful tool for engaging employees across the enterprise on the importance of water. However, according to a 2007 review of corporate water reporting done by the Pacific Institute, most company reports do not provide key information necessary for external stakeholders to assess water risks (**see Figure 3**).[71]

71. Mari Morikawa, Jason Morrison, and Peter Gleick. "Corporate Reporting on Water. A Review of Eleven Global Industries," Pacific Institute, Oakland, California, May 2007.

Figure 3. Water Reporting Rates – Types of Information Published in Non-Financial Reports



Source: "Corporate Reporting on Water. A Review of Eleven Global Industries." Pacific Institute

The Pacific Institute report showed that only 20 percent of 121 of the largest companies in 11 water-intensive industry sectors report water-related risks or describe programs to assess water risks, and only 10 percent describe supply chain considerations in relation to water management. Not a single company reported on the actual water use or wastewater data of their suppliers. Another problem with present corporate water disclosure is the inconsistency of reporting methods and metrics, which makes comparison and benchmarking difficult for external audiences. The study also found that site-specific information or local facility-level data is often not provided. However, considering the location-specific character of water scarcity, such information is crucial to fully understanding water risks.

Despite these general inadequacies in corporate water reporting, some companies are starting to recognize the importance of water disclosure. The Pacific Institute study found that more than 90 percent of the 121 companies reviewed publish water performance information, most commonly total freshwater use. As companies and investors start to recognize the materiality of water-related business risks, there will be more pressure to publish water information in both non-financial (e.g., sustainability or CSR reports) and financial reports (e.g., annual reports or SEC filings) (**see Box 13**).

In Section 5, we present a high-level framework for companies to use to communicate (and for investors to assess) their water management practices and performance. We recommend companies reference this framework in disclosing their water-related risks in sustainability reports and SEC filings. It consists of:

- Measurement and risk assessment associated with the company's water footprint;
- Stakeholder engagement and communication regarding the company's water performance, risks, and objectives;
- Integrated and strategic water management planning.

Box 13. Water risk disclosure in SEC filings

The Coca-Cola Company discloses water information not only in its annual sustainability reports, but also recently in its 2007 10-K filing with the U.S. Securities and Exchange Commission (SEC). In the most recent filing, Coca-Cola explained the relationship between water and its core business functions, listing water quality and scarcity as one of its risk factors, stating: "As demand for water continues to increase around the world, and as the quality of available water deteriorates, our system may incur increasing production costs or face capacity constraints which could adversely affect our profitability or net operating revenues in the long run."

Source: The Coca-Cola Company, 2008. Form 10-K submitted to the United States Securities and Exchange Commission for the fiscal year 2007, Washington, D.C.

4.2 Business Opportunities

By pursuing strategic water management, companies can not only build resiliency for water and climate change risks, but also turn water risks into financial and competitive advantage. Below we suggest various approaches to identify and create business opportunities.

Profits in efficiency and innovation

Decreasing water use and impacts in direct operations and across a company's value chain can reduce costs for water use and wastewater discharge, as well as the corresponding energy costs associated with heating or pumping that water. Integrated approaches to better water and energy management have allowed companies such as IBM at a single plant to achieve savings of $3 million while increasing output by 33 percent. This included a 27 percent reduction in water purchases, almost $1 million in water treatment savings, and $1.5 million in energy savings, without incurring any capital costs.[72] In addition, such efficiency measures can demonstrate a company's commitment to water management, boost public image, and help build positive relations with the communities where it operates.

To the extent that water-related risks are embedded in companies' supply chains, there are also vast opportunities to manage and save water by working with suppliers (**Box 14**).

Box 14. Steelcase – streamlining the supply chain

Steelcase, a leading player in the office furniture industry, has teamed up with a major supplier, DuBois Chemicals, in an effort to reduce water and energy use and minimize their waste stream. As the result of a failed procurement bidding process, DuBois was asked by Steelcase to conduct a "lean and clean" assessment of their operations at the Ohio manufacturing facility. Over the course of five months of collaboration and production process changes, DuBois experienced savings and reductions in several areas including energy and waste streams. For example, the new process led to energy savings of 60 percent totaling approximately $27,369 in 2007. Overall waste stream reductions of 85-95 percent were realized while water usage was reduced by 80 percent overall at savings of $48,128. Furthermore, the innovative use of chemicals in the revamped process resulted in 20–30 percent less volume of wastewater discharged. The pilot project led to reduced chemical use (and procurement) at the Ohio facility, spurring Steelcase to roll out DuBois' process changes at all of its North American and global facilities.

Sources: U.S. EPA, "Steelcase and DuBois-JohnsonDiversey," Lean Manufacturing and Environment. See: http://www.epa.gov/lean/studies/steelcase.html

Corporate Climate Response Conference, Chicago, September, 22-24, 2008. See: http://www.greenpowerconferences.com/corporateclimateresponse/CCR08_usdl.html

72. Peter R. Williams, "Water Consumption Management," IBM Corporation, Presentation given at Corporate Climate Response Conference, Chicago, September 22-24, 2008. See:http://www.greenpowerconferences.com/corporateclimateresponse/documents/CCR2/PeterWilliams.pdf

Development of "water-savvy" products is an emerging area of opportunity in a variety of sectors. Detergent manufacturers, for example, have identified consumers' product use with the highest level of water consumption relating to the product's life cycle. In fall 2007, Proctor & Gamble switched all of its liquid detergents to a compact formula. By fall 2008, P&G's Fabric Care and Home Care segment had seen a 10 percent increase in net sales growth. Similarly, Unilever's All Small & Mighty brand detergent uses 74 percent less water than regular detergents. The new concentrated formulas use up to 44 percent less water, as well as less packaging. In 2007, U.S. sales of the Small & Mighty brand reached $140 million,[73] up from over $100 million in 2006.[74]

Companies providing high water-efficiency equipment, including shower heads, faucets, toilets, washing machines and other residential and commercial appliances are also benefiting as water prices rise, new regulations are adopted and awareness of efficiency potential increases in certain markets. New technologies that reduce water use are appearing on the market regularly, such as digital X-ray machines for hospitals and efficient commercial dishwashers and washing machines.

Box 15. Unilever reduces water use across much of its value chain

Unilever has been comprehensively analyzing its direct and indirect water impacts, taking into account water used by suppliers in growing raw materials, as well as by consumers using Unilever products. Since introducing systematic measurement of its water use in 1995, the company has reduced its direct water consumption per ton of production by roughly 62 percent. In 2007, Unilever reduced total water consumption in its operations worldwide by 4.9 million cubic meters and the volume of water per ton of production by 7.5 percent, exceeding its target of 4.7 percent.

On the supply chain side, Unilever is providing financial and technical support to help tomato farmers in Brazil convert to drip irrigation, reducing water consumption by up to 30 percent while increasing crop yield. At tea plantations in Tanzania, drip irrigation trials completed in 2007 showed 10 percent water saving compared to current irrigation techniques, with no yield loss. This is equivalent to saving 70 liters of water for every kilo of black tea produced. When fully implemented on a 3,000 hectare farm, Unilever anticipates that 700 million liters of water will be saved.

On the consumer end, the company estimates that a reformulated version of laundry detergent requiring less rinsing will have considerable water use impacts in water-stressed areas of India where washing clothes accounts for large portion of domestic water consumption. Based on assumptions about laundry habits, Unilever estimates potential savings in the region of 14 billion liters of water a year.

Source: "Our biggest challenges," Unilever.
See: http://www.unilever.com/ourvalues/environment-society/sustainable-development-report/environ-sus/water/default.asp

Water saving and wastewater treatment technologies, such as water filtration, purification and conservation products, is another fast-growing market. Water purification and air quality systems are projected to increase 5.6 percent per year to $1.5 billion in 2012, with sales of replacement filters and membranes reaching $2.7 billion over that same span.[75] These advanced water treatment technologies are aimed at alleviating stressed water supplies, as well as minimizing overall consumption, energy use, and costs associated with creating and recycling water. Venture capital and entrepreneurship experts expect

73. http://www.unilever.com/Images/ir_ar07-annual-report-full_tcm13-122592.pdf?linkid=dropdown

74. Patrick Cescau et al. "Unilever 2006 Results Presentation," Presented in London, February 8, 2007. See: http://www.unilever.com/Images/ir_Q4 2006 Results speech_tcm13-84121.pdf

75. Freedonia Group, Inc., "Consumer Water Purification & Air Cleaning Systems," Market Research, October 1, 2008. See: http://www.marketresearch.com/product/display.asp?productid=1350472&xs=r

that the water sector will see an increase in technology breakthroughs and investments in the next three to five years. From an investor perspective, increasing water scarcity and the challenges of a sustainable water future present a high potential for growth, as well as business opportunities in sectors related to water.

Box 16. Emerging markets in water technology

According to data from the Cleantech Network, from 2004 to the first quarter of 2007, 71 water and wastewater treatment deals were finalized, totaling nearly $303 million. For example, Atlantium, a developer of water disinfection solutions in Israel, received two rounds of funding worth $27 million, while MIOX Corp., a manufacturer of on-site generators for water disinfection in Albuquerque, NM, received venture capital funding worth $30 million. Multinationals are also innovating for water conservation. In 2006, General Electric established a global research and development center in Singapore for its Water & Process Technologies group, which will build on earlier successes in reverse osmosis membrane and other technologies for water purification and filtration.

Source: "At the Crest of a Wave: A Proactive Approach to Corporate Water Strategy," Business for Social Responsibility and Pacific Institute, September 2007. See: http://www.bsr.org/reports/BSR_Water-Trends.pdf

Looking beyond the fence line to improve water systems and management[76]

Companies can also turn water risks into opportunities by taking measures that help stabilize and improve the water resources of the wider communities in which they operate. For years, there was no easy way to invest in the maintenance and restoration of environmental services, nor much incentive for businesses to do so. Over the past decade, however, numerous options have emerged, ranging from regulatory constraints on water withdrawals to market mechanisms in environmental services, including those related to wetlands and water pollution.

For example, in the case of 'payments for watershed services,' companies in need of reliable flows of clean water have entered into private deals to pay upstream landowners to change their land management practices around rivers to ensure less sediment, establish more plant cover on river banks, and thus enable more reliable flows. The case of New York City entering into an agreement with upstream farmers to protect source water rather than building another expensive water treatment plant is a well-known example of a municipality thinking innovatively to meet its water needs at a fraction of the cost of taking a conventional approach.

Bottled water companies are also recognizing the role that watershed thinking can play in protecting their commercial product. Nestlé Waters has worked with neighboring landowners to protect watersheds and sensitive areas crucial to ensuring high quality source water in a cost-effective manner.[77] In China, some companies are calling for upstream water quality and ecosystem protections in order to improve the quality of downstream supplies.[78] These cases demonstrate that it can be more cost-effective to invest in watershed-level approaches rather than expensive technological on-site solutions to address either shortages or quality problems.

76. Parts of this section were excerpted from "At the Crest of a Wave: A Proactive Approach to Corporate Water Strategy," Business for Social Responsibility and Pacific Institute, September 2007.
77. Daniele Perrot-Maitre,"The Vittel payments for environmental services: a "perfect" PES case?" International Institute for Environment and Development, September 2006..
78. A. Hawn, "Watershed Services: The New Carbon" The Ecosystem Marketplace.com, 2005.

Box 17. Coca-Cola aims to become "water neutral"

The Coca-Cola Company has committed to offset all water used for manufacturing to the environment, with the overarching goal of being "water neutral." The Coca-Cola water stewardship framework focuses on three components: reduce, recycle, and replenish. First, the company pledged to set specific goals in 2008 for its global operations to reduce use of water. Second, it is striving by 2010 to have 100 percent of facilities returning water used in manufacturing processes back to the environment at a level that will continue to support aquatic life. Lastly, Coca-Cola is working to replenish water through support of watersheds and community-level sustainability water programs. The objective within this third component is to support conservation programs that balance or "offset" the water used in producing all of the company's beverages.

Related Coca-Cola efforts include collaboration with the World Wildlife Fund to achieve large-scale results through a five-year effort to conserve freshwater resources. This initiative is supported by a $20 million grant from the company. Coca-Cola is already involved in 120 community-based water projects in 50 countries that focus on water supply, sanitation, hygiene, watershed management, productive water use, and education and awareness.

Sources: "The mark we make today shapes the future," The Coca-Cola Company 2006 Corporate Responsibility Review." See: http://www.thecocacolacompany.com/citizenship/pdf/corporate_responsibility_review2006.pdf

"Sustainability," The Coca-Cola Company. See: http://www.thecoca-colacompany.com/citizenship/index.html

4.3 Collective Action – Emerging Tools and Initiatives

Because water is a shared resource, its management can be a sensitive social, cultural and environmental issue, particularly in times of drought and water restrictions. Companies can rarely achieve the best water management outcomes on their own, as most solutions to water supply, quality and sanitation issues require co-management approaches involving collective action and partnerships. Such approaches can give companies competitive advantages through alignment of their corporate water strategies with public policy goals and multi-stakeholder initiatives. These activities can include collaborations with local communities, NGOs and government agencies, as well as peer-to-peer collaborations with other businesses.

The United Nations, in concert with national governments, has established a set of goals, known as the Millennium Development Goals. One of these goals is to reduce by half the number of people worldwide without access to clean water or adequate sanitation by 2015. There is a growing recognition that businesses are well positioned to play a role in achieving these goals. The public, in turn, has growing expectations that the private sector, often perceived as complicit in global water threats, should do its part regionally and internationally to address these challenges. Especially in regions under high water stress, or where substantial populations lack safe and affordable water, there is increased pressure for companies to work with local stakeholders, including water agencies, community groups and other industry water users to share and manage limited resources more equitably and efficiently.

By pooling resources and bringing together a wide range of expertise and knowledge through partnerships for a common goal, companies can respond to water-related concerns more efficiently and effectively than through individual actions. Collaborative actions are particularly crucial in assessing and addressing climate change impacts, since there are large gaps in knowledge and information related to climate change and water, especially data and prediction modeling at the watershed level. **Appendix C** provides six examples of emerging collective action initiatives and tools for water stewardship that would significantly reduce business risks for companies.

5. Investor Action

"Corporate disclosure of water-related risks is seriously inadequate and is typically included in environmental statements prepared for public relations purposes rather than in the regulatory filings on which most investors rely."[79]

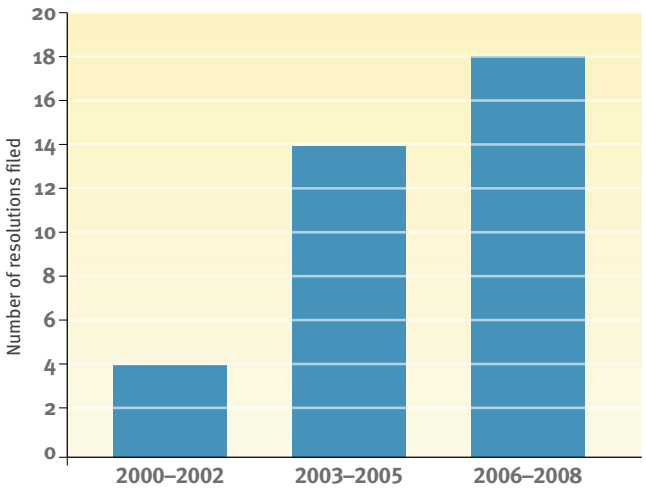
~JPMorgan

A growing number of Wall Street firms are turning their attention to the risks and opportunities posed by global water scarcity. Citi, JPMorgan, Merrill Lynch and Morgan Stanley all issued water-focused research reports in 2008. The reports highlighted both emerging investment opportunities and massive data gaps investors and analysts face in assessing corporate water risks.

5.1 Shareholder Advocacy on Water

The number of shareholder resolutions focusing on water issues has grown in recent years (**see Figure 4**). Sectors particularly exposed to shareholder advocacy around water issues include the food, beverage, oil, and chemical industries. For instance, there has been one or more water-related shareholder resolutions filed against The Coca-Cola Company every year since 2004.

Figure 4. Shareholder Resolutions Addressing Water Issues



Source: Data from the Interfaith Center for Corporate Responsibility's Ethvest database. See: www.iccr.org

Recognizing the plethora of risks associated with water, investors are now filing resolutions asking companies for more disclosure on water practices and performance, including water policies, environmental and social impacts of water use, and water usage throughout the value chain. A large number of resolutions also ask for new company-wide policies on the human right to water, water reuse and recycling, and water-efficient technology.

79. Marc Levinson et al., "Watching water: A guide to evaluating corporate risks in a thirsty world," JPMorgan Global Equity Research, March 31, 2008.

5.2 Proactively Managing Investment Risk

In addition to shareholder activism, below are some of the key actions investors can take to better understand and manage water-related risks.

1) Assess companies' exposure to water risks

As discussed in previous sections, water risks manifest themselves in various ways depending on how water is used in the company's direct operations and value chain, where the most significant water use is located, and the quality of water needed or discharged, among other factors. Below we provide a checklist of five key questions investors should ask in order to assess corporate water risks, including those caused or exacerbated by climate change. Each of the five questions is supported by follow-up questions that can be used as additional evaluation criteria.

2) Demand more and better disclosure of water-related information

Since water-related risks depend largely on local hydrological, environmental and socio-economic conditions, it is often difficult to obtain an accurate estimate of risk exposure using the information provided in companies' annual or sustainability reports, which typically focus on corporate-level data. Investors must spearhead the push toward more meaningful, comprehensive, and comparable corporate water disclosure. Further, water risk exposure should be disclosed in companies' 10-Ks and other financial filings. Investors have been advocating for the disclosure of these types of risks (physical, regulatory and competitive) in SEC filings since 2004.

3) Encourage companies to incorporate water issues into their current climate change strategy

Impact on water resources is one of the most significant climate change risks companies face and there is a strong link between water and energy. Investors can and should apply experiences and lessons learned with climate change risks to water risk.

4) Emphasize the opportunity side of water availability/quality issues

Investors should also highlight water-related opportunities relevant to specific businesses and industries. Spurring senior management and board-level evaluation of water risk can in many instances serve as the impetus for more strategic consideration of business opportunities.

Considerations for Assessing Companies' Exposure to Water Risk

1. Does the company measure and understand its water footprint?

a) Does the company know its direct water use?

- Does the company measure how much water is required and used in its direct operations?
- Does the company measure the quantity and quality of its wastewater discharges?
- Does the company understand the connections between its energy and water use?

b) Does the company know its indirect water use?

- Does the company know which parts of its supply chain are most water-intensive?
- Is the company aware of how much water is used or discharged in association with its products and services?

2. Has the company assessed the business risks associated with its water footprint?

a) Has the company evaluated water risks associated with its direct operations?

- How are the company's direct operations dependent on quantity, quality, timing and cost of water supply?
- What is the nature of the company's water rights and legal obligations with regard to quantity, quality, price, reliability and duration of water supply?
- What percentage of the company's direct operations is located in water-stressed or ecologically sensitive regions? Is water demand growing in those regions?
- What percentage of the company's direct operations relies on energy sources that require large amounts of water to produce?
- What percentage of the company's direct operations is located in the areas where local population lacks access to clean and affordable drinking water and sanitation?
- What is the water infrastructure situation and water management capacity in regions with key operations?
- How does the amount and source of the company's water withdrawals impact local communities and ecosystems?
- How does the quantity and quality of wastewater discharges impact local communities and ecosystems?
- What is the quantity/quality of the company's wastewater discharges in relation to permitted levels and/or industry averages?

b) Has the company considered water risks related to its extended supply chain?

- How might the company's supply chain be affected by changes in water supply, quality, reliability, and price?
- What percentage of the company's supply chain is located in water-stressed or ecologically sensitive regions?
- Has the company considered water-related regulatory risks of key suppliers?
- What percentage of the company's key suppliers relies on energy sources that require large amounts of water to produce?

c) Has the company considered water risks related to its products and services?

- How are the company's products and services dependent on quantity, quality, reliability and the price of water supply? How do they perform in relation to competitors?
- What percentage of the company's product users and customers is located in water-stressed or ecologically sensitive regions? Are those customers and users located in regions with growing water demand?
- Do the company's services and products have potential impacts on water resources when disposed of or recycled?
- How will water supply, quality, and reliability in the company's key markets be potentially affected by climate change?
- What percentage of the company's direct operations and supply chain are located in areas where the local population lacks access to clean and affordable drinking water and sanitation?
- Has the company considered water-related regulatory risks of its products and services?

d) Does the company have contingency plans to respond to water risks, such as supply disruptions, price increases, more stringent regulations, etc.?

- Does the company conduct contingency planning for regions with key operations?
- Does the company have contingency plans to respond to supply chain disruptions or raw material price increases due to water issues?

e) Has the company assessed how climate change will affect water availability, reliability, price and quality?

- How might the company's direct operations be affected by changes in water supply quantity, quality, and reliability due to climate change?
- Does the company assess how its raw material supply and supply chain may be affected by change in water supply quantity, quality and reliability due to climate change?

- Does the company assess how users of its products and services may be affected by change in water supply quantity, quality and reliability due to climate change?
- How might water price, permits and water quality regulation be affected by climate change in key places the company operates?

3. Does the company engage with key stakeholders (e.g., local communities, non-governmental organizations, government bodies, suppliers, employees) as a part of its water risk assessment, management, and long-term planning?

- Does the company consult with local communities and non-governmental organizations regarding water impacts as it considers where and how to site or expand its operations?
- Does the company work with local governments, businesses and communities to develop and implement integrated watershed management in locations with key operations?
- Does the company collaborate with governments and communities to address issues related to access to drinking water and sanitation?

4. Has the company integrated water risk into its overall business planning and governance structure?

a) Does the company have a water management policy and plan?

- Has the company's top management (i.e. CEO and board) publicly expressed its commitment to sustainable water management?
- Has the company made water management the responsibility of a direct report to the CEO and ensured that a board-level committee has water management as part of its mandate?
- Has the company formed an integrated water-energy team staffed by a representative of every business function that uses significant amounts of water or energy, or has the potential to pollute water?
- Has the company developed water management programs with specific priorities, tasks, measures and quantified performance goals based on the company's water, energy, and carbon footprints and impact assessments?
- Does the company have a system that promotes continuous improvement in water management and performance?

b) Does the company meet or exceed regulatory requirements for water use and quality?

- Does the company meet or exceed regulatory requirements in its direct operations?
- Does the company work with suppliers to make sure that they meet or exceed regulatory requirements for water use and quality?

c) Does the company's water management planning integrate the impacts of climate change on water resources?

- Does the company consider impacts of climate change on water for siting or investment decisions?
- Does the company consider the energy implications of water management plans and activities?

d) Does the company develop or invest in business opportunities that address water issues?

- Does the company develop and provide solutions to water scarcity and quality, such as water efficiency or treatment technologies, water-efficient products, etc.?
- Does the company apply best available technologies to improve water efficiency or wastewater quality?
- Does the company consider energy implications of measures and solutions to water issues?

5. Does the company disclose and communicate its water performance and associated risks?

a) Does the company report and communicate its water policies and management plans?

b) Does the company report its water performance, using broadly accepted metrics or indicators, such as those provided by the Global Reporting Initiative?

- Does the company report its water use/discharges for direct operations?
- Does the company report water use/discharges at the regional or facility levels?
- Does the company report water use/discharges for key suppliers?

c) Does the company disclose water-related risks in its 10-K or other financial filings?

Appendix A:
Water Footprint Intensity of Select Sectors

APPAREL		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Growing and harvesting cotton plants	Textile manufacturing; Garment manufacturing	Retail and marketing; Distribution	Consumer's garment use
Withdrawal	*Intensity*	**High**	Medium	Low	**High**
	Description	Freshwater withdrawal for cotton crop irrigation (22,000L/kg)	Freshwater for textile manufacturing, in particular for dyeing and bleaching (500L/kg)	Water use in retail and commercial facilities (bathroom, kitchen, landscaping)	Water use to wash garments (1,650L/kg)
Discharge	*Intensity*	Medium	**High**	Low	Medium
	Description	Agricultural runoff containing fertilizer, pesticides	Wastewater discharge containing dye, bleach, detergent and other processing chemicals	Wastewater discharge from retail and commercial facilities (bathroom, kitchen, landscaping)	Wastewater discharge containing detergent

ELECTRONICS/ HIGH-TECH		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Silicon extraction and production; Metal and plastic production	Silicon wafer/semiconductor and electronic parts manufacturing	Product assembly and manufacturing; Retail and marketing; Distribution	Consumer's product use; Disposal
Withdrawal	*Intensity*	Medium	**High**	Medium/Low	Low
	Description	Freshwater for scrubbing and cooling; Freshwater for silicon extraction	Ultra-pure water for wafer manufacturing; Freshwater for scrubbing and cooling; A typical fab can use as much as 3 million gallons of water per day	Water use in assembly, retail and commercial facilities (bathroom, kitchen, landscaping)	Water use in electronics recycling process
Discharge	*Intensity*	**High**	**High**	Low	Medium
	Description	Wastewater containing heavy metal, acid and toxic chemicals	Wastewater containing heavy metal and toxic chemicals	Wastewater discharge from retail and commercial facilities (bathroom, kitchen, landscaping)	Electronic waste – leachate and runoff containing heavy metal and toxic chemicals from landfill

BEVERAGE		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Food crop production, such as sugar cane, barley, fruits	Bottle, container and packaging manufacturing; Ingredient suppliers	Bottling; Distribution; Retail and marketing	Beverage consumption; Container recycling and disposal
Withdrawal	*Intensity*	**High**	Medium	**High**	Medium
	Description	Freshwater for crop irrigation; Freshwater for rinsing and cleaning crops	Freshwater to manufacture containers and packaging; Freshwater for washing and cooling	Water as a product ingredient; Water use in dispensing products; Water withdrawal for bottled water; Washing, cleaning, pasteurization (steam)	Water use to wash and recycle beverage containers
Discharge	*Intensity*	Medium	Low	Medium	Medium
	Description	Agricultural runoff; wastewater from food processing facilities containing fertilizer, pesticides, and herbicides.	Wastewater discharge containing toxic chemicals	Wastewater discharge from beverage manufacturing processes such as brewing, cooking, and fermentation; Wastewater discharge from retail and commercial facilities (bathroom, kitchen, landscaping)	Wastewater discharge; Impact of discarded bottles and packaging on aquatic ecosystems

FOOD		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Food crop and livestock production	Container and packaging manufacturing; Ingredient suppliers	Meat and food processing; Distribution; Retail and marketing	Cooking and preparation of food products; Recycling and disposal of packaging and containers
Withdrawal	*Intensity*	**High**	Medium	**High**	Medium
	Description	Freshwater for crop irrigation; Freshwater for rinsing and cleaning crops; Freshwater requirements for livestock – drinking, sanitation, grazing	Freshwater to manufacture containers and packaging; Washing and cooling	Water as a product ingredient; Washing, cleaning, pasteurization (steam)	Water to wash and cook food products; Water to wash and recycle containers
Discharge	*Intensity*	**High**	Medium	**High**	Medium
	Description	Agricultural runoff, wastewater from food processing facilities containing fertilizer, pesticides, and herbicides; Feedlot runoff; Animal waste	Wastewater discharge containing toxic chemicals	Wastewater discharge from meat and food processing; Wastewater discharge from retail and commercial facilities (bathroom, kitchen, landscaping)	Wastewater discharge; Impact of discarded packaging on aquatic ecosystems

BIOTECH/ PHARMACEUTICAL		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Production of basic chemicals; Food and animal products	Container and packaging manufacturing	Pharmaceutical product manufacturing; R&D; Distribution; Retail and marketing	Disposal of unused products
Withdrawal	*Intensity*	Low	Low	Medium	Low
	Description	Freshwater for agricultural raw material (plants, animal)	Freshwater to manufacture containers and packaging; Washing, cooling	Water as a product ingredient; Washing, cleaning, pasteurization (steam)	Drinking and sanitation water for consumers
Discharge	*Intensity*	Low	Low	**High**	Medium
	Description	Agricultural runoff, wastewater from food processing facilities containing fertilizer, pesticides, and herbicides; Feedlot runoff; Animal waste	Wastewater discharge containing toxic chemicals	Wastewater discharge that contain high concentration of chemicals and/or microbial organisms; Wastewater discharge from retail and commercial facilities (bathroom, kitchen, landscaping)	Disposal of unused products may release toxic chemicals and biological agents into the surrounding environment

FOREST PRODUCTS		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Growing and maintenance of forests	Suppliers of logs, wood chips	Paper and pulp manufacturing; Wood product manufacturing; Distribution; Retail and marketing	Recycling and disposal of paper and wood products
Withdrawal	*Intensity*	Medium	Low	**High**	Medium
	Description	Precipitation and irrigation requirements to grow and maintain forests; Water use to combat forest fire	Freshwater use to manufacture containers and packaging; Washing, cooling	Freshwater use in pulp and paper-making process; Cooling water and steam generation	Water use to manufacture paper using recycled material
Discharge	*Intensity*	Low	Low	**High**	Medium
	Description	Agricultural runoff containing fertilizer, pesticides and herbicides; Increased sediments from logging operations	Wastewater discharge from cleaning and cooling process	Wastewater discharge from pulp and paper-making process has high concentration of cleaning and bleaching chemicals, inks, oils; Wastewater discharge from retail and commercial facilities (bathroom, kitchen, landscaping)	Wastewater discharge in recycled paper-making process has high concentration of cleaning and bleaching chemicals, inks, oils

METALS & MINING		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Mining and drilling	Suppliers of mining or manufacturing equipment	Manufacturing of steel and other metals	Recycling and disposal of metal products
Withdrawal	*Intensity*	**High**	Low	**High**	Medium
	Description	Water used for dust control, drilling and as slurry in product transportation	Cooling water or steam generation in manufacturing facilities	Freshwater use for cooling, boiler and rinsing	Water use for cooling, boiler and rinsing
Discharge	*Intensity*	**High**	Low	**High**	Medium
	Description	Runoff and wastewater containing dust, sediments and metals and toxic chemicals; Drainage water from mines that require treatment to discharge	Wastewater containing heavy metals and other potentially toxic chemicals	Wastewater containing heavy metals and other potentially toxic chemicals	Wastewater containing heavy metals and other potentially toxic chemicals

ELECTRIC POWER / ENERGY		Raw material production	Suppliers	Direct operations	Product use/ end of life
Value chain segment		Extraction and refining of oil, natural gas and coal	Suppliers of power generation equipment	Power generation; Power distribution; Maintenance	Energy used for various purposes
Withdrawal	*Intensity*	**High**	Low	**High**	N/A
	Description	Water used for steam and water flooding of reservoirs, steam for oil extraction, cooling and steam generation for refining processes,	Cooling water or steam generation in manufacturing facilities	Water use for cooling, steam generation, flue gas treatment; Hydropower generation requires reliable water flow	Water is not needed to use electricity. However, there is often a strong energy-water connection – energy is required to heat or deliver water
Discharge	*Intensity*	**High**	Low	**High**	N/A
	Description	Wastewater containing metals and hydrocarbons	Wastewater containing heavy metals and other potentially toxic chemicals	Significant thermal discharge impacts on local ecosystems	No wastewater discharge associated with energy use

Appendix B:
Water Risks of Select Sectors

	Physical Risks	Reputational Risks	Regulatory Risks
APPAREL	• Cotton production stage has the largest water footprint, and is most susceptible to water shortage and climate change impacts. • Change in water supply, quality and price impacts textile manufacturing. • Majority of manufacturing happens in water-scarce regions.	• Large percent of textile/garment manufacturing operations are located where local communities lack access to reliable and affordable drinking water. • Water withdrawal for cotton irrigation and agricultural runoff affects water resources shared with local community. • Wastewater discharge from dyeing, bleaching or laundering processes have negative impacts on local water sources and ecosystems, and may damage company's brand image and reputation.	• Water scarcity, increased demand and competition for freshwater resources can affect license to operate, and change the pricing structure. • New or more stringent wastewater regulations may increase cost for treating wastewater in textile manufacturing.
ELECTRONICS	• Silicon wafer production requires large amounts of ultra pure water (UPW) for cleaning and rinsing. Thus changes in water availability and quality significantly impact these operations. • Offshore productions are increasingly moving to Asia and Pacific Rim where water resources are under stress. • UPW production is very energy-intensive and susceptible to disruption or increased cost of energy supply due to water scarcity.	• UPW production requires potable water, putting water use in direct competition with local populations. • Contamination of groundwater resources by electronic waste may damage manufacturers' brand image and reputation. • Decline in economic, social and physical wellbeing of consumers due to the lack of access to clean water may affect market growth for electronic products in emerging economies.	• Water scarcity, increased demand and competition for freshwater resources can affect license to operate, and change the pricing structure. • New or more stringent wastewater regulations may increase costs for treating wastewater.
BEVERAGE	• Most significant water use is embedded in the raw material production phase. Severe drought or changes in patterns of precipitation can decrease crop yield and quality. • Potable water is principal and non-substitutable ingredient for beverage products. Water scarcity or contamination of water sources may force bottling or manufacturing facilities to shut down or relocate.	• Beverage manufacturing requires potable water, putting water use in direct competition with local populations. • Decline in economic, social and physical wellbeing of consumers due to the lack of access to clean water may affect market growth for beverage products in emerging economies.	• Water scarcity may raise the price of water, cap the amount of withdrawal, or result in the suspension of license to use water resources.
FOOD	• Most significant water use is embedded in crop or livestock production. • Changes in precipitation patterns, severe drought and flooding due to climate change may decrease crop yield and quality. • Increased temperature and dry weather due to climate change may raise water requirements for crops and livestock.	• Agricultural runoff and wastewater from food/meat processing facilities may have negative impacts on local water sources and ecosystems, potentially damaging company's brand image and reputation. • Meat has a very large water and carbon footprint, with a potential reputational risk and impact on demand for meat products. • Higher water temperature due to climate change may increase water borne pathogens, and fruit and food supply may face more risk of contamination, and subsequent reputational and financial damage.	• Water scarcity and increased demand and competition for freshwater resources can change the pricing structure. • More stringent requirements for wastewater quality may be imposed on food/meat processing facilities.

	Physical Risks	Reputational Risks	Regulatory Risks
BIOTECH / PHARMA	• High quality water is an essential input used as a main ingredient as well as in processing and cleaning, making this sector especially susceptible to changes in water availability and quality. • Production of pure/ionized water and clean steam generation is energy-intensive, making this sector susceptible to disruption or increased cost of energy supply due to water scarcity.	• Rising consumer concerns about pharmaceutical contamination in water sources. • Use of high quality water puts industry in direct competition with local populations.	• New or more stringent wastewater regulations may increase cost for wastewater treatment and discharge
FOREST PRODUCTS	• Paper product manufacturing is very water-intensive. Increasing water scarcity and climate change may disrupt or raise cost of water supply. • Climate change may increase risk of forest fire, due to increased temperature, drought and water shortages for fire fighting. • Changes in precipitation patterns due to climate change may negatively affect forest growth. • Pulp and paper manufacturing, is extremely energy-intensive, making this sector susceptible to disruption or increased cost of energy supply due to water scarcity.	• Pulp and paper manufacturing has high volume and concentration of chemicals in wastewater, which can lead to significant financial and reputational risks in case of spills and leaks. • Planting, harvesting and logging operations can have negative impacts on local water resources, which can damage companies' brand image and reputation.	• Stringent wastewater regulations may increase cost for wastewater treatment and discharge. • Water scarcity, increased demand and competition may raise the price for water, cap amount of withdrawal, or suspend license to use water sources.
METALS & MINING	• Siting of mining operations depends on location of raw material/mines. These operations cannot change their locations to adapt to water scarcity. • Climate change is expected to increase the frequency and severity of extreme weather events. Mining operations may be disrupted by severe rain or flooding. • Higher atmospheric and water temperature may impact process cooling and may increase the amount of water required for operation.	• Because of high volume and toxicity of wastewater and mine drainage, impacts of leaks on water resources and surrounding ecosystems can be high, raising the risks for reputational damage.	• Stringent wastewater regulations may increase cost for wastewater treatment and discharge. • Since a high volume of water is required for mining and metal manufacturing, the impact of price increases or water supply disruptions can be significant.
ELECTRIC POWER / ENERGY	• Thermal power generation requires large amounts of cooling water. Hydropower plants are at risk of decreases in water flow. • An increase in the severity of extreme weather events will damage power generation/ distribution facilities. • Higher atmospheric and water temperatures increases the amount of water required for cooling. • Oil and natural gas supply may be disrupted or become more expensive due to severe weather conditions.	• The temperature and salinity of return flows can damage ecosystems and habitats, which may damage company's brand image or reputation.	• New or more stringent wastewater regulations may increase cost for wastewater treatment and discharge. • Since a high volume of water is required for power generation, the impact of price increase or water supply disruption can be significant.

Appendix C: Examples of Collective Action Tools and Initiatives for Corporate Water Stewardship

The CEO Water Mandate

The CEO Water Mandate,[80] established by the UN Global Compact in 2007, is currently one of the most comprehensive and visible cross-sectoral, public-private partnerships on water. The Mandate represents both a call-to-action and a strategic framework for responsible water management by business. It is voluntary in nature, but is built around six core areas of responsibility with which its endorsers must commit to and demonstrate improvement: Direct Operations, Supply Chain and Watershed Management, Collective Action, Public Policy, Community Engagement, and Transparency.

The initiative serves as a platform to collect and share experiences with regard to the six elements, with the ultimate aim of advancing best practice in the field. It carries out its work through multi-stakeholder policy dialogues, facilitation with respect to on-the-ground partnerships, and the dissemination of existing and new tools as well as other resources. The Mandate is currently developing a Transparency Framework that will provide endorsers with a compilation and analysis of innovative practice and common approaches for reporting on water management and performance. With membership limited to UN Global Compact members, the Mandate now features close to 50 endorsers with sector- and geographic-diversity, including companies such as Coca-Cola, Dow Chemical, Levi Strauss, Nestlé, PepsiCo, Royal Dutch Shell and Unilever.

Water Footprint Network (WFN)

The WFN[81] is a nascent non-profit entity working to promote water stewardship through the advancement of the concept and methodology of "water footprinting," a spatially and temporally explicit measure of direct and indirect water use by producers, consumers, and regions. The WFN engages in developing standards for water footprinting, developing tools for implementing water footprinting, facilitating harmonization and dissemination of the water footprint methodology, and providing support and advice to practitioners utilizing the methodology. WFN has strong ties with the Water Footprint Working Group (WFWG), an ad hoc body which has worked since 2007 to develop the water footprint methodology for corporations and their supply chains.

80. "Water Sustainability," UN Global Compact, May 13, 2008. See: http://www.unglobalcompact.org/issues/environment/water_sustainability/index.html

81. "About WFN: Mission," Water Footprint Network, 2008. See: http://www.waterfootprint.org/?page=files/WFN-mission

World Business Council on Sustainable Development's Water Project

The World Business Council on Sustainable Development (WBCSD) has been active in water issues since 1997. WBCSD's Water Working Groups have developed several publications and tools, including Global Water Tool released in 2007. This web-based software tool is designed for companies with global operations and extended supply chains to assess their water use and risks associated with water availability. It also contains the UN's water availability predictions for 2025, enabling users to assess both current and future risks.

WBCSD also recently launched the Fairwater Initiative to promote responsible water management in the private sector. It aims to enable businesses to:

- Engage with stakeholders on water issues,
- Collaborate with a wide range of similarly-focused initiatives,
- Better understand the complexities of water concerns
- Reduce duplication of work in the private sector.[82]

The initiative is currently developing an evolving "Fairwater Framework" which will first serve to map out existing related initiatives and eventually define best practice in water stewardship through three dimensions: 1) Process of Stewardship, 2) Methodology of Measurement, and 3) Concepts & Principles.

Alliance for Water Stewardship (AWS)

The AWS is an initiative seeking to develop a global freshwater stewardship certification program. This voluntary standards-based water stewardship program will provide independent attestation (e.g., certification) that rewards responsible water management with recognition and competitive advantage. The Alliance intends for this certification scheme to be applicable both to water "users" (businesses) and water "providers" (utilities). The initiative is currently in the standards development phase in which a range of stakeholders are defining what constitutes water stewardship. Originally conceived and initiated by The Nature Conservancy, Water Stewardship Initiative, and the Pacific Institute, the Alliance is expanding to include participation from a variety of stakeholders, including NGOs, water utilities, and businesses.

82. Jack Moss, "FairWater Stewardship." World Business Council on Sustainable Development Stakeholder Workshop, London, June 17-18, 2008. See: http://www.wbcsd.org/web/projects/water/fairwater.zip

World Economic Forum Water Initiative

In 2003, the World Economic Forum, in association with UNEP, launched its Water Initiative, a program intended to promote public-private partnerships on water projects and responsible management of watersheds.[83] The initiative, comprised of members from various sectors of society, including businesses, NGOs, international organizations, and governments, works to create multi-stakeholder networks that facilitate cooperation on water projects that are well-developed, bankable, with appropriate leadership and financing plans.[84] The initiative has focused to date on water projects in India and South Africa. It has played an integral role in the creation of the Indian Business Alliance on Water (IBAW), India's first national public-private partnership on water, and has supported the New Partnership for Africa's Development (NEPAD) Business Foundation, a leading facilitator in the multi-stakeholder water network being established in South Africa.

The Global Environmental Management Initiative (GEMI)

GEMI[85] is a collection of corporations aiming to promote best practice in global environmental health and safety. Established in 1990, GEMI currently has 37 members representing more than 22 sectors. Though GEMI does not focus specifically on water, it has developed two water management tools:

Water Sustainability Tool: this tool is designed to help companies create a corporate-level water management strategy by laying out five management stages businesses can follow to develop and implement water strategy.

Water Sustainability Planner: this tool provides detailed guidance for assessing water use-related business risks at the facility level. It does so with step-by-step instructions on how to assess water use inventories.

83. "World Economic Forum Water Initiative Launched," Info-Prod Research, June 2003. See: http://findarticles.com/p/articles/mi_hb5561/is_200306/ai_n22667435

84. "Regional Activities of the Water Initiative," World Economic Forum, 2008. See: http://www2.weforum.org/en/initiatives/water/RegionalActivities/index.html

85. "About GEMI," Global Environmental Management Initiative (GEMI), 2008. See: http://www.gemi.org/aboutgemi.aspx

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