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Special Report

Managing Industrial Water in the Age of Climate Change



INTRODUCTION

Managing Industrial Water in the Age of Climate Change

Water scarcity, exacerbated by climate change, poses special risks for industry. Business leaders and scholars explored these risks and promising solutions at a recent Wharton conference on Industrial Water Management, co-sponsored by the school's Initiative for Global Environmental Leadership (IGEL) and Suez. This report extends that discussion, focusing on the global challenge and some of the innovative ways that the business and financial communities are responding.



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Only 2.5% of the earth's water is fresh and most of that has been locked up in glaciers for millennia. Now those glaciers are melting into the sea at an alarming rate, as the average global temperatures continues to rise. The warming atmosphere is disrupting the normal water cycle, desiccating some areas that are already parched and flooding others with more precipitation than they can handle. Industry, too, is threaten by these changes, but there are signs that companies are rising to the challenge.

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Companies around the world are facing up to the planet's dwindling supply of freshwater. The first step for many is to reduce the amount of water they need to run their plants and produce their products. For those that rely on agriculture, it's important to maximize the amount of freshwater available in the environment while helping farmers minimize their water use. Meanwhile, aging infrastructure is forcing companies in water-stressed areas to focus increasingly on water reuse and desalination.

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Where others see a looming water crisis the financial community sees opportunity. Investment is flowing into water utility stocks and into the water-related companies bundled together in exchange-traded funds (ETFs). Value investors are contributing to public-private partnerships that support major infrastructure projects, and venture capital and other early-stage investors are providing important seed money for innovative startups. What is currently in short supply are funds that can help innovators bridge the gap between proof of concept and full-scale implementation.

SPONSORS

The Initiative for Global Environmental Leadership (IGEL) and Suez Environnement have partnered with Knowledge@Wharton to create this special report.





Water Scarcity and Climate Change: Entwined Challenges to Industry

IT'S WIDELY RECOGNIZED THAT THE TWO MAJOR ENVIRONMENTAL CRISES FACING THE WORLD TODAY – freshwater availability and climate change – are intimately connected, and aggravate each other in a planetary-level feedback loop.

Eric Orts, a professor of legal studies and business ethics at Wharton and director of Wharton's Initiative on Global Environmental Leadership (IGEL), points out that the mass migration back to cities – which will accommodate 75% of the world's population by 2050 (according to the U.N.), also worsens water-scarcity issues by concentrating demand. Orts spoke at a recent IGEL's Industrial Water Management Conference.

At the conference, Adnan Mansour, a global product leader at GE Power and Water, said that population growth of three billion by 2050 would lead to a 55% increase in international water demand, and clean water stress for two thirds of the world's people by 2025. The problem, he said, is exacerbated by water delivery infrastructure that in many cases is more than 100 years old.

According to the U.N., which declared the 10 years between 2005 and 2015 the International Decade for Action on clean water, "Water scarcity is both a natural and a human-made phenomenon. There is enough freshwater on the planet for seven billion people but it is distributed unevenly and too much of it is wasted, polluted and unsustainably managed."

FRESH WATER WAS ALWAYS SCARCE

Water scarcity was rated the number one global risk by the Davos World Economic Forum in 2015. It's significant that fresh water was never an abundant commodity, and represents only 2.5% of the world's available water supply, according to the U.S. Geological Survey (USGS). And

because more than two-thirds of that supply is locked into glaciers and snowcaps, a much smaller amount is available for human and industrial consumption.

Climate change is worsening the problem. "Globally, the negative impacts of future climate change on freshwater systems are expected to outweigh the benefits," said Sanjay Patnaik, a management professor at George Washington University and an IGEL fellow. "And current water management practices may not be robust enough to cope with the impacts of climate change."

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According to Sandra Postel, director of the Global Water Policy Project and the author of *Last Oasis: Facing Water Scarcity*, "Climate change is fundamentally altering the movement of water across the planet. As air warms, it expands, which allows it to hold more moisture. This, in turn, increases rates of both evaporation and precipitation, generally enhancing dryness in dry areas and wetness in wet areas. In the Colorado River Basin in the Southwest, for example, scientists expect that rising temperatures alone will cause the Colorado River's average flow to decrease by 5% to 35% by 2050, in large part due to increased rates of evaporation and transpiration. So water scarcity will deepen as the planet warms and evaporation rates increase."

Even the increased precipitation caused by climate change – when warmed, moisture-heavy air can contribute to water scarcity. According to the British newspaper *The*

Guardian, “Although more rainfall can add to fresh water resources, heavier rainfall leads to more rapid movement of water from the atmosphere back to the oceans, reducing our ability to store and use it.” Glaciers and snowpacks release their accumulated water slowly, but rainwater quickly fills lakes and reservoirs to their capacity; what’s left is runoff that can’t be stored and causes flooding.

Melting glaciers are also a short-term boon to rivers and lakes, but the effect ends when the ice is gone. The Grace Communications Foundation points out that more than 50% of the world’s freshwater comes from mountain runoff and snowmelt, and “once these glaciers have melted away, they can’t be restored.” All the freshwater stored in polar ice simply adds to the rising seas. “Those areas that rely on water from the mountains, from snow cover and glaciers, will have severe water shortages,” notes.

“It used to be that water was hardly mentioned at major climate change conferences ... and now it has a dominant presence.”

— Patrick Cairo

WATER SECURITY CHALLENGES

Patnaik adds that another way that climate change affects the water supply is through increasing the risk of severe storms. “That’s a common finding of most climate-change models. Areas hit by tropical storms will see increasing severity, and more flooding. Developing countries are particularly vulnerable, because they don’t have the means to accommodate and to adapt to changes that include sea-level rise and flooding. Countries such as Bangladesh and low-lying island nations, without financial resources to mitigate the effects, are most at risk.”

Storms aren’t the only climate-related challenge facing the developing world. According to the World Bank, “For poor countries that have always faced hydrologic variability, climate change will make water security even more difficult and costly to achieve. Climate change may also reintroduce water security challenges in countries that for 100 years have enjoyed reliable water supplies and few, if any, water shocks.”

Agriculture, too, suffers from climate-induced water scarcity, while at the same time contributing to it. The Intergovernmental Panel on Climate Change (IPCC)

reports that irrigation accounts for nearly 70% of global water withdrawals. But higher temperatures will, in general, lead to increased irrigation demand — even without changes in precipitation levels. “Of all sectoral water demands, the irrigation sector will be affected most strongly by climate change,” IPCC said.

Climate change reduces not only the amount of freshwater but also the quality. According to the Environmental Protection Agency (EPA), precipitation increases in the Northeast and Midwest “could cause problems for the water infrastructure, as sewer systems and water treatment plants are overwhelmed by the increased volumes of water. Heavy downpours can increase the amount of runoff into rivers and lakes, washing sediment, nutrients, pollutants, trash, animal waste and other materials into water supplies.”

The EPA reports that rising sea levels are likely to inundate coastal areas and turn some freshwater supplies salty. Parts of the Everglades — which currently recharge Florida’s underground Biscayne aquifer — are at risk. Biscayne is the primary source of drinking water for the Florida Keys. The shallow fresh aquifers on islands are also very vulnerable.

RISKS FOR INDUSTRY

The worsening state of global water access comes clearly into focus through the lens of industrial expansion, because manufacturing, refining and other processes are major water users. And as climate change leads to droughts, more serious storms and sea-level rise, companies are being forced to alter major decisions about plant location, capacity and likely longevity.

A report from Ceres and the Pacific Institute, “Water Scarcity and Climate Change: Growing Risks for Businesses and Investors,” concludes, “The impact of water scarcity and declining water quality on businesses will be far reaching.” The Ceres/Pacific Institute report says that companies are already seeing smaller water allocations, tighter regulations, higher water prices, increased community activism — “and increased public scrutiny of corporate water practices.” The World Bank predicted in a May 2016 report that, by 2050, inadequate water supplies could significantly harm economic growth in some global sectors, reducing gross domestic product in some countries by as much as 6% — “sending them into sustained negative growth.”

Are corporations recognizing the conjoined climate change/water crisis and its potential impact on their

businesses? And, more importantly, are they acting on it? Definitely, says Patrick Cairo, senior vice president for corporate development at major utility-owning water company Suez North America. "My view is that the awareness of water scarcity and its economic impact has grown tremendously," he said. "It used to be that water was

hardly mentioned at major climate change conferences such as those sponsored by the United Nations and other global organizations, but six or seven years ago these organizations started saying we needed more dialogue on water issues, and now it has a dominant presence." 💧





How Industry Is Addressing the Growing Water Crisis

FARMERS USE A LOT OF WATER, as do the nation's power plants. So it's not surprising that agriculture and electrical power generation each accounted for 38% of freshwater use in 2010, according to the United States Geological Survey (USGS). What is remarkable is that all of U.S. industry used only 5% of the nation's freshwater in 2010, a decrease of 12% from 2005. Some of this decline was the result of the 2008 recession, but much of it was driven by increased efficiency, a trend that has continued unabated since 1985, says the USGS.

This growing efficiency reflects a growing awareness of water risk across virtually every industrial sector. When MillerCoors conducted a materiality assessment in 2014 to learn which sustainability issues were "most material to the long-term success of MillerCoors and our stakeholders," water ranked highest after alcohol awareness, says Jonah Smith, the company's sustainability manager.

All of U.S. industry used only 5% of the nation's freshwater in 2010.

Other major food and beverage companies share MillerCoors' concern, as do clothing manufacturers, oil refineries, pharmaceutical and chemical companies, among many others. Most realize that "a reduction of any kind in water availability will have a direct impact on their productivity," explains Patrick Cairo, senior vice president of corporate development for Suez North America.

Speaking at Wharton's Industrial Water Management Conference, co-sponsored by the school's Initiative for Global Environmental Leadership (IGEL) and Suez, Cairo noted that, "A day doesn't go by without news of difficulties in industrial water supplies, including droughts in California and Texas." Such droughts, he emphasized, can be devastating to companies that have invested huge sums on new or expanded facilities

REDUCE DEMAND FIRST

Like other food and beverage companies, MillerCoors takes water conservation very seriously. The company, says Smith, is already well on its way to achieving an industry-low water-to-beer ratio of just three-to-one.

The brewer has also done its homework when it comes to reducing water use within its breweries. Fernando Palacios, executive vice president and chief integrated supply chain officer, and several members of MillerCoors sustainability improvement team, visited parent company SABMiller's Latin American breweries, which are industry leaders in water-use reduction. The team came back with a number of best practices, including "short-interval controls," which empower managers on the line to make decisions in real time — such as fixing leaks. This one practice now accounts for 75% of the breweries' water conservation. The other 25% comes from technological improvements.

As impressive as these efforts are, the reality is that, like most food and beverage companies, most of MillerCoors' water use occurs outside the brewery walls. According to Smith, "We found that about 90% of the water use associated with our product actually happens in the agricultural supply chain — for irrigation to grow our barley and hops, for instance."

So MillerCoors teamed up with the Nature Conservancy and others to develop water-conserving measures at a showcase barley farm in Silver Creek Valley, Iowa. The farm bred new drought-resistant varieties of barley and proved that farmers could save enormous amounts of water and maintain high-quality barley by turning off the end guns on pivot irrigation and turning off irrigation altogether earlier in the season. The farm “saved something like 550 million gallons of water in the first three years,” says Smith. The company brought these ideas and others to the 816 independent farmers who belong to its Growers Direct Program.

PROTECTING WATERSHEDS.

In addition to reducing the water used in its beer, brewery operations and agricultural supply chain, MillerCoors also made watershed sustainability a part of its efforts. The goal: “Restore a volume of water equal to the final product volume from our breweries located in water-stressed watersheds.”

In Irwindale, California, which has endured a severe drought for several years, for instance, MillerCoors and the National Forest Foundation launched a pilot program in 2015 to remove *arundo donax*, an invasive giant reed that uses much more water than better-adapted native plants. The idea for the project grew out of the brewer’s membership in the California Water Action Collaborative, a group of food and beverage companies, their suppliers, conservation groups and others that depend on a healthy watershed. In fact, Smith says that Jonathan Radtke, water resource sustainability manager for Coca-Cola North America, was the first person to alert him to the possible project and put him in touch with potential partners.

Coca-Cola, too, set itself the goal of safely returning an amount of water equal to what the company uses in its finished beverages and their production. And Coke, which replenished 94% of 2014 sales volume, said that it and its bottling partners were on track to meet the 2020 goal five years ahead of schedule. As part of this effort, the company engaged in a range of locally focused community water projects, as well as projects aimed at improving water use efficiency in its plants and returning water to watersheds through wastewater treatment.

COSTS-BENEFIT ANALYSIS

Industry has essentially three sources it can turn to for the fresh water it needs: municipal water, reused water and desalinated water.

Municipal water is the least expensive, but it is also the most vulnerable. To start with, many municipal systems in water-stressed areas are at risk of being overwhelmed by both population growth, which increases demand, and severe droughts and floods, which reduce supply. Age is also a risk factor in many ways. The pipes that carry the water are frequently scores of years, and sometimes more than a hundred years old and leaking badly. A 2015 IGEL/Knowledge@Wharton report put the amount of water leaking out of aging pipes at seven billion gallons a year, with many older cities reporting losses of between 15% and 30% of total supply. The EPA, meantime, estimates there are 240,000 water main breaks a year in the U.S., according to *The New York Times*.

The structure of public water management systems is also out of date. “California’s water rights system, for example, traces back many, many years and many people think it’s not modern enough to deal with the numerous challenges that climate change produces,” noted Sanjay Patnaik, a management professor at George Washington University and a former lecturer.

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Reused water, or treated wastewater, is the next best source in terms of cost and reliability, says Cairo. The range of technologies available for treating wastewater is extensive, explains Jeff Garwood, formerly president and CEO of GE Water & Process Technologies and now the managing member of Liberation Capital. “There are technologies available to treat any level of water to any level of water,” he explains.

“More and more there will be reuse of water in the sense of sewage that’s going to be used to reinject into aquifers. Not that long ago it was unheard of, now it’s required in a lot of places.” In Singapore, for instance, which completed a massive effort to become water-independent in the past decade, NEWater (a brand name for reclaimed water in Singapore), which starts out as sewage, is treated to such a high level that it is used both by industry and to supplement drinking water when necessary, according to Garwood.

Of course, not all water has to be treated to the same standards. Drinking water has to be free of bacteria,

minerals and toxins that are harmful to human beings. The water that's used in a plant's cooling tower or boiler does not, although some industrial purposes demand even higher levels of demineralization than drinking water. The key is to treat wastewater according to how it will be reused.

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— Jeff Garwood

When both municipal and reused water prove insufficient, industry turns to the most expensive source: desalination. At present only about 1% of the world's freshwater comes from desalination (and 70% of that is in the Middle East), but the U.N. expects 14% of the global population to be using desalinated water by 2025. Still, despite technological improvements that have reduced the costs associated with desalination, the process remains very costly.

EXPLORING OPTIONS IN TEXAS

Oil refineries in Texas are being forced by climate change to consider all three sources. In Corpus Christi, for

instance, local industry, which is dominated by refineries, already uses 40% of the city's fresh water, and the municipal supply is facing major challenges. Not only is the water-distribution system in need of repair, but the reliability of the water supply itself is also threatened. Like much of Texas, the city suffered from severe drought from 2005 until 2015. Since then, torrential rains have led to floods and three water-boil advisories in 10 months.

The many refineries in the area are looking to expand, which would benefit the local economy, but says Cairo, "They are trying to get certainty of water availability. And they find that if they just rely on the surface water system, which the city relies on, they're going to have problems." So two parallel studies are now underway.

According to Cairo, "There is a major study that will be released sometime at the end of the year on what availability exists for reuse and what the estimated costs are going to be." In addition, Corpus Christi is looking into the feasibility of building a desalination facility, which Cairo says "would be more or less a dedicated facility to service industry." The final decision about how to proceed may well involve all three sources to some extent: upgrading the existing municipal system, enhancing the city's ability to reuse water and, possibly, the construction of a desalination plant.

Industry may represent a small percentage of the nation's water usage, but as these examples, and the IGEL/Suez conference make clear, companies are playing an outsized role in ensuring that the country has the water it needs. 💧





Financing the Future of Industrial Water

TO SURVIVE THE GROWING WATER CRISIS, industry needs both continued access to fresh water and innovative technologies to make more efficient use of what is likely to be an increasingly expensive commodity. These twin needs require massive investment. To provide the water needed by both industry and human populations, thousands of miles of ancient pipes must be repaired or replaced.

This vital work, according to a 2012 American Water Works Association (AWWA) report entitled “Buried No Longer: Confronting America’s Water Infrastructure Challenge,” will cost at least \$1 trillion and take 25 years. Even then, new reuse and desalination facilities will be needed in certain parts of the country, and they don’t come cheap either. It cost \$1 billion to open a new desalination plant in drought-stricken Carlsbad, California late last year.

In contrast to these massive efforts, the innovation needed to increase efficiency is most often the work of relatively small start-ups, which need seed money to develop and test new technologies and further investment to scale up ideas before they can be sold to larger companies with the resources to roll them out.

INFRASTRUCTURE INVESTMENT

In today’s precarious, low-yield economy, it’s not difficult to find people eager to invest in water infrastructure. Where others see desperate need, the investment community sees tremendous opportunity. Much of the interest among investors is in “unglamorous but consistently performing companies whose gear are embedded in wells, distribution systems and plants,” notes *U.S. News & World Report*. And numerous investment vehicles have been created to tap into this interest.

Private funds, such as Water Asset Management, offer targeted investments, while mutual funds and exchange-

traded funds (ETFs) make it possible for investors to buy a number of industrial companies serving the water industry. These broad-based funds are not “pure plays,” because they invest in companies that are engaged in many projects and products, only some of which are related to water.

To provide water for industry and human populations, thousands of miles of ancient pipes must be repaired or replaced in the U.S. and will cost at least \$1 trillion and take 25 years.

Bloomberg reports that water ETFs “have attracted just shy of \$2 billion in assets since their inception in the mid-2000s, a lot for a niche category.” And in recent days, their performance has been solid. PowerShares Water Resources Portfolio, for example, the largest of the water ETFs, has \$980 million in assets and returned 9.15% in the first half of 2016, while Guggenheim S&P Global Water Index, with assets of \$367 million, returned 10.5% in the same period. To be sure, the ETFs have not fared as well over the past five years, underperforming the S&P 500, but many analysts remain optimistic about the future

Big players, too, are getting involved in water infrastructure, often through public-private partnerships (P3s). According to the National Association of Water Companies, more than 2,000 municipalities have embraced P3s, which allow them to improve and maintain their water infrastructure without adding to their debt.

The financing for such projects typically involves a consortium of investors. Suez, for example, which might take responsibility for operating a water project, a renewed water system or a new desalination plant, “may bring 20%

THE GROWING VALUE OF WATER

Adam Smith, who wrote “The Wealth of Nations” in 1776, was troubled by how little the marketplace valued water compared to other non-essential commodities. Today, climate change, population growth and crumbling infrastructure are changing the way investors think about water. Goldman Sachs started calling water “the petroleum for the next century” in 2008.

Three years later, Citigroup’s top economist Willem Buiter said, “Water as an asset class will, in my view, become eventually the single most important physical-commodity based asset class, dwarfing oil, copper, agricultural commodities and precious metals.” And just last year, Richard Sandor, known as the “father of financial futures,” predicted that the long-awaited emergence of water as an investable commodity is imminent. “We are on the verge of breaking into water markets in the world,” Sandor told a gathering at Northwestern University’s Medill School of Journalism.

of the financing,” explains Patrick Cairo, senior vice president of Corporate Development for Suez North America. “The construction and engineering companies that are doing the design-build may bring another 20%, and then you go to private equity, which would bring in the remaining 60%.”

Public-private partnerships are attracting the interest of major investment banks. Goldman Sachs, for instance, lists such partnerships as one of its primary approaches to the water market. Properly structured, says Goldman, these P3s “bring the benefits of operational efficiency and economies of scale, facilitating rate stability and high-quality, long-term public water access.”

MISSING FROM FINANCING INNOVATION

The innovations that will eventually dominate the water industry are frequently conceived by entrepreneurs in small start-ups that need seed money in some form, whether from angel investors or from early-stage venture capitalists, to develop their ideas. In the past year, there was little venture capital to be had. According to data from PitchBook, there were 39 water start-ups or early-stage venture capital deals in 2015, totaling \$44.17 million. “That’s only 2.2% of the clean tech funding market and 0.07% of the broader startup market,” notes Scott Mosley, director of investment strategies at The Water Council.

But according to Frederick Schmuck, formerly a senior vice president of GE’s Capital Markets team and now a member of Liberation Capital, innovative approaches to water scarcity, water efficiency and resource reclamation attracted considerable seed money just before the financial crisis. While many of the start-ups that found funding ultimately failed, says Schmuck, quite a few succeeded. In fact, he estimates, “There are 10,000 water-related companies around the world with revenues of a few million dollars that are very close to profitable or slightly profitable.”

To be successful, innovators have to prove not only that they can make a profit, but that their business model is scalable, which takes additional investment.

Success for these innovative companies almost always means being acquired by a major water company with the resources to take their innovations into the mainstream. There have been many examples over the past 15 years. In 2006, for instance, GE Water & Process Technologies purchased Zenon Environmental Inc., a global leader in advanced membranes for water purification, wastewater treatment and water reuse. Then two years later, GE purchased Ionics, another water-purification company.

Such purchases are made for strategic purposes. Large corporations like GE Water don’t want to buy companies too early; they’re looking for successful and scalable innovations that will help advance their long-term interests. GE Water says it is committed to solving “the world’s most complex challenges related to water scarcity, quality, productivity, the environment and energy,” hence its interest in successful water purification companies.

Schmuck believes there is a unique opportunity now for a fund that attracts investors who want to help successful start-ups prove themselves and become attractive targets for strategic investors. “The venture capital guys did their job back in 2005-2008,” says Schmuck, “Now it’s time to harvest what they did.”

Whether or not such a fund materializes, the need for innovative solutions to water scarcity seems certain to attract investors, just as larger-scale projects continue to increase the water sector’s share of private investment. ♦

USEFUL LINKS:

<http://pacinst.org/app/uploads/2014/04/growing-risk-for-business-investors.pdf>

<http://water.org/water-crisis/water-sanitation-facts/>

<http://reports.weforum.org/global-risks-2015/#frame/20ad6>

<http://www.gracelinks.org/2380/the-impact-of-climate-change-on-water-resources>

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<http://water.worldbank.org/topics/water-resources-management/water-and-climate-change>

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