BROWN ADVISORY

Please Mind the Gap

A REPORT ON THE WORLD'S LIMITED WATER RESOURCES

Executive Summary

Barry Goldwater once said that a man from the West will fight over three things: water, women and gold, and usually in that order.

The Arizona Senator understood the value of water. Though, for many, water scarcity seems as implausible as oxygen scarcity. We simply turn on the tap and it flows. However, that is certainly not the case the world over.

In essence, water is a commodity like any other - a commodity, we might add, with no substitute. When scarce, it's a commodity more valuable than either gold or oil. But many of us take water for granted, failing to realize how much we require in our daily lives.

In fact, each and every day, indoor per capita water use in the typical single family home amounts to approximately 69.3 gallons. Of that, showers and toilets alone account for more than 43%. By comparison, the average two-egg omelet requires approximately 130 gallons to produce. Complementing two eggs with a single cup of coffee takes another 37 gallons.

In whole, the soft commodities that support the meaty diet of the typical Western consumer demand around 1,320 gallons of water per day to produce. Asia and Africa, on the other hand, primarily subsist on vegetarian diets that require less than half that amount. As emerging market economies continue to grow and personal incomes begin to rise, the diets in these regions will begin to shift. Vegetables and grains will be replaced by a Western eating standard based predominately on protein. The amount of water needed to accommodate this shift will be substantial. The Food and Agriculture Organization estimates that when you account for the fact that the world's population is likely to rise by another 2 billion by 2025, the world will need as much as 60% more water for agricultural purposes alone to feed the extra 2 billion mouths. That amount roughly equals the total water used in the world outside of Asia today.

Securing the amount of reliable, sustainable water resources needed to simply grow what we eat and drink will require a significant investment from both the public and private sectors. The story, however, does not end there. Manufacturing a single ton of steel entails the use of more than 62,000 gallons. Silicon chip fabrication consumes nearly 2000 gallons of ultra-pure water for a single, eight-inch wafer. The entire energy production process, from the extraction of critical natural resources like coal, oil and natural gas to the conversion of those resources into electric generating capacity, relies on facilities having perpetual access to fresh water. Meaning, the story of water is the story of human consumption (See Figure 1).

figure 1. **Water use per product produced**
Source: United States Environmental Protection Agency

Product	Water Use (gallons)
Car	39,090
Barrel of beer	1,500
Barrel of crude oil (refining process)	1,851
Ton of steel	62,600
Ton of cane sugar	28,100
The average annual U.S. residential use	107,000

As we write, a new era of demand for the world's natural resources has emerged. Emerging market economies have firmly embarked on a path that aims to emulate the middle-class way of the West. In addition to richer diets, people are demanding more cars, computers, clothes and cell phones. In this pursuit, ample supplies of industrial commodities like copper and oil will be critical.

Relatively speaking, water's significance in this transformation will be just as critical. One would be hard-pressed to find a point of economic productivity where water did not play a vital role. But unlike industrial commodities, water is traditionally seen as an "entitlement" with a "price" that should not be defined by fundamental economic principles like supply and demand. For the reasons addressed in this brief, we conclude that the economics of water will have to change. As a result, many businesses – both new and existing – will seek to provide solutions to this challenge. Many of these solutions will present significant investment opportunities for investors.

Our report on this issue is presented in four principal sections:

Section 1, "Earth: A Water Planet" outlines the central problem – that despite the fact that approximately 80% of the earth's surface is covered by water – only a tiny fraction is fresh, accessible and suitable for civilization's needs.

Section 2, "Peak Water" addresses that fact that even though water is a renewable resource, the total amount of water in certain geographic regions is in serious decline, implying that water, which is generally viewed by many as widely available and inexpensive, can no longer be taken for granted.

Section 3, "Please Mind the Gap" quantifies the gap between projected water requirements in 2030 and current available supply. For the three main user groups – agricultural, municipal and industrial – closing the supply-demand gap for the world's water resources will not be a question of if, but rather a question of when and how.

Section 4, **"Investment implications"** examines the level of investment needed on an annual basis over the next ten years to narrow the gap between supply and demand. We pay specific attention to the capital and operating expenditures that address the problem through a variety of upstream and downstream solutions.

1. Earth: A Water Planet

The U.S. Environmental Protection Agency (EPA) estimates that approximately 80% of the earth's surface is covered by water. Unlike conventional oil, water is considered a static resource. That is, we have approximately the same amount of water today as we had when the earth was formed.

Despite the general abundance, only around 3% of the world's water is fresh. Of all the fresh water on earth, 69% remains inaccessible, locked up in icecaps, glaciers and permafrost. The next 30% rests in deep, underground aquifers, many of which are too difficult or costly to access. In the end, surface water in the form of rivers and streams, the primary source of civilization's needs, accounts for only seven-thousandths of 1% of the world's total fresh water supply (See Figure 2).

Although the quantity represented by our rivers and streams seems infinitesimally small, the scarcity challenge does not stem from a lack of available supply. In fact, most countries, especially those in the Northern Hemisphere, have more than enough water to satisfy their current and future needs. The problem, rather, is one of uneven distribution.

Uneven water distribution means that the majority of countries within the Southern Hemisphere face water scarcity in one of two forms. Economic scarcity, the lesser of the two, exists when regions with adequate supply have insufficient infrastructure or financial capacity to deliver available recourses to end users. For example, South America and parts of Australia and Central Africa face economic scarcity. However, the majority of people live in the region that stretches west from the Asian continent, through Persia, and into the heart of the Mediterranean world. These societies face actual physical water scarcity (See Figure 3).

As Steven Solomon, author of ***Water: The Epic Struggle for Wealth, Power, and Civilization,*** notes: "Globally, one-third of all stream flow occurs in Brazil, Russia, Canada, and the United States, with a combined one-tenth of the world's population. Semi-arid lands with one-third of the world's population, by contrast, get just eight percent of the available supply." Asia, in particular, houses roughly two-thirds of the world's population with only one-third of its runoff.

figure 2. **Lots of water - but only a fraction is on the surface and fresh**
Source: CLSA - Asia-Pacific Markets

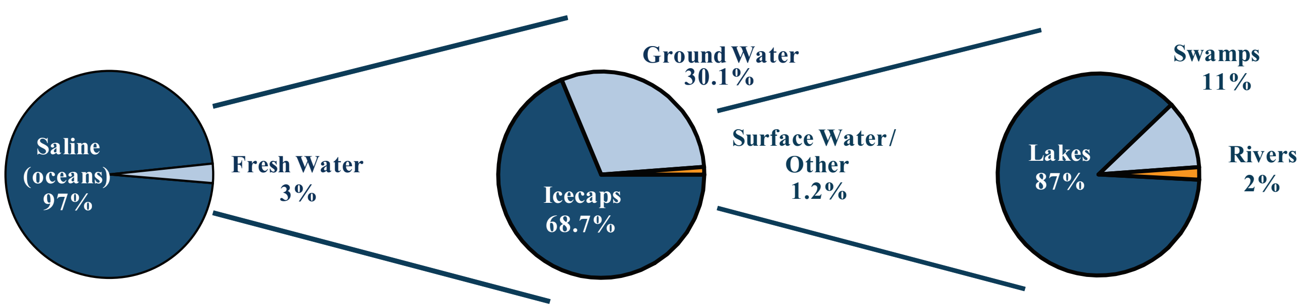
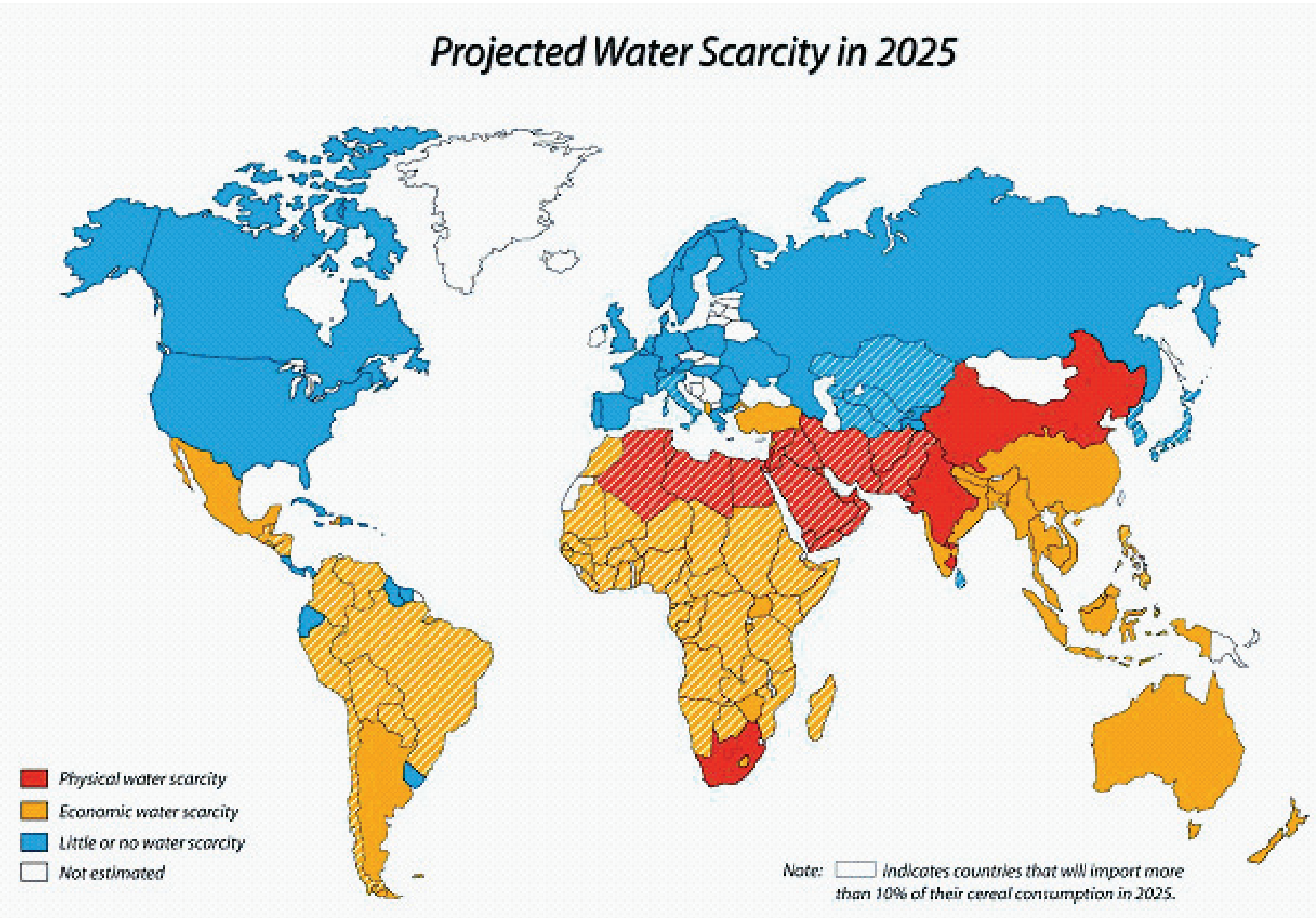


figure 3. **Lots of water — but uneven distribution means freshwater scarcity**
Source: International Water Management Institute. According to the International Rice Research Group, one of the largest non-profit agricultural research centers in Asia, the areas in red will have limited water supply, while the areas in blue will have little or no water scarcity. The regions in orange will still have available water supply, but the costs to obtain water will be high. The shaded regions indicate countries that will import more than 10% of their cereal consumption in 2025.



Within Asia, China and India arguably face the greatest challenge. China lays claim to only 7% of the world's freshwater supply despite boasting 20% of its population. India accounts for 17% of the world's population with only 4% of its freshwater supply.

To complicate matters, the limited water that does exist often suffers from severe contamination. More than three-quarters of the surface water flowing through China's urban areas is considered unsuitable for drinking or fishing. Unfortunately, many Chinese people have no choice.

The Organization for Economic Co-operation and Development (OECD) estimates that hundreds of millions of Chinese citizens are drinking water polluted with inorganic pollutants such as arsenic, as well as toxins from untreated factory wastewater, inorganic agricultural chemicals and leeching landfill waste. As a result, approximately 100,000 Chinese citizens die each year from water pollution-related illnesses.

Water pollution not only strains the public health, but it also places notable headwind on China's growing economy. A World Bank study estimated that the water crisis is already costing China about 2.3% of GDP, of which 1.3% is attributable to the scarcity of water and 1% to the direct impacts of water pollution.

India confronts a similar dilemma. Monsoon rains, which can deliver up to 90% of India's annual precipitation, occur over the span of a few short months. The majority of this highly-concentrated precipitation is subsequently lost in the form of runoff. Consequently, millions of Indians rely on finite groundwater supplies to support both municipal and agricultural use.

The advent of affordable pumping technology in combination with subsidized electricity enabled millions of poor landowners to tap deep, underground reserves. Subsequently, agricultural exploitation of that resource ensued. Furthermore, water's connection to economic growth has only intensified the overconsumption of its aquifers. Today, India has become the world's largest groundwater user, with 60% of its irrigated agriculture and 85% of drinking water supplies reliant on the capacity to tap underground reservoirs.

The nature of India's rainfall prohibits these underground aquifers from being adequately replenished. Like oil wells, these water stocks eventually run dry. Water tables throughout India have begun dropping at alarming rates. As demand begins to outstrip supply, tension between stakeholders continues to rise.

figure 4. **Middle East population boom (*population in thousands*)**
Source: Simmons@Company International; U.S. Census Bureau

	1970	1980	1990	2000	2010 Est.	CAGR
Bahrain	220	348	501	635	738	3%
Egypt	33,574	42,634	54,907	65,159	80,472	2%
Iran	28,854	39,422	56,669	63,273	67,038	2%
Iraq	9,414	13,233	18,140	22,679	29,672	3%
Israel	2,903	3,737	4,478	6,115	7,354	2%
Jordan	1,503	2,163	3,267	4,688	6,407	4%
Kuwait	748	1,370	2,142	1,974	2,789	3%
Lebanon	2,383	2,899	3,440	3,791	4,125	1%
Oman	783	1,185	1,794	2,432	2,968	3%
Qatar	115	237	446	627	841	5%
Saudi Arabia	6,109	9,999	16,061	23,147	29,207	4%
Syria	6,258	8,752	12,500	16,471	22,198	3%
Turkey	35,758	45,048	56,561	67,329	77,804	2%
United Arab Emirates	249	1,000	1,826	3,219	4,976	8%
Yemen	7,098	9,133	12,416	17,407	23,495	3%
Total	**135,969**	**181,160**	**245,148**	**298,946**	**360,084**	**2%**

The country's seven major rivers may provide some short-term relief. Nevertheless, like China, these rivers suffer from an onslaught of industrial chemicals, farm pesticides and sewage. As groundwater supplies continue to shrink, the reliance on these polluted, over-utilized waterways will only increase, intensifying the competition between industrial, agricultural and municipal users. In March, the Indian state of Kerala asked the Coca-Cola Company to pay $47 million in compensation for allegedly depleting local groundwater supplies. Like China, the status quo in India cannot last.

Moving due west from the Indian subcontinent, water shortages are nothing new to the countries within the Middle East and North Africa (MENA), the world's driest region. Unlike the intricate system of rivers and lakes that span the North American continent, or even the over-utilized, pollution-filled rivers that make their way throughout Southeast Asia, only a handful of rivers, including the Nile, Tigris and Euphrates, support the entire MENA region.

With only 0.9% of global water resources, a relatively recent population boom is making a scarce resource even scarcer. In fact, since 1970, the population of this region has been growing roughly twice as fast as that of the United States. Today, more people live in the MENA region than in the United States and Canada combined (See Figure 4).

According to the World Bank, several countries in the region already spend over 20% of their budgets on water. Seven countries in particular are using more water every year than is available to them, mainly by over-pumping aquifers. Without efficiency gains and investment in supplemental supplies, this option will soon cease to exist.

Key Takeaways

- Uneven water distribution means that the majority of countries in the Southern Hemisphere face economic water scarcity.
- China, India and the MENA region face physical water scarcity. As a group, these countries account for approximately 42% of the world's population, yet they possess roughly 12% of the world's freshwater supply.
- The growing supply-demand gap is only enhanced by the prevalence of pollution and the unsustainable reliance on non-replenishable sources.

2. Peak Water

A global market in which water is redistributed across continents and oceans, much like any other industrial commodity, would appear to be a viable solution. If we can deliver oil from the deserts of the Middle East to cities in Middle America, why can we not ship water from Canadian lakes to cities in Northern China?

For starters, water is heavy. A single gallon of water weighs 8.34 pounds, slightly more than a gallon of oil, depending on the oil's density. The sheer weight makes pumping water out of the ground or over land to higher elevations a very energy-intensive operation. This link between energy and water means that the cost of transporting water over relatively short distances can dramatically raise the price (See Figure 5). Those costs go up considerably for longer distances.

figure 5. **Summary comparison of oil and water**
Source: The Pacific Institute, Biennial on Freshwater Resources 2008-2009

Characteristic	Oil	Water
Quantity of resource	Finite	Literally finite, but practically unlimited at cost
Renewable or non-renewable	Non-renewable resource	Renewable overall, but with locally non-renewable stocks
Flow	Only as withdrawals from fixed stocks	Water cycle renews natural flows
Transportability	Long-distance transport is economically viable	Long-distance transport is not economically viable
Consumptive versus non-consumptive uses	Almost all use of petroleum is consumptive, converting high-quality fuel into lower quality heat.	Some uses of water are consumptive, but many are not; overall, water is not "consumed" from hydrologic cycle
Substitutability	The energy provided by the combustion of oil can be provided by a wide range of alternatives	Water had no substitute for a wide range of functions and purposes
Prospects	Limited availability; substitution inevitable by a backstop renewable source	Locally limited, but globally unlimited after backstop source (e.g., desalination of oceans) is economically and environmentally developed.

A recent paper published by the Hoover Institute estimates that the price for water transported short distances ranges between $0.75 and $1.50 per cubic meter. Other estimates project transportation costs (by tanker ship in this case) at roughly $0.49 per cubic meter. For comparison, the average price of a cubic meter of water in the United States (which is relatively water-rich) is $0.75. In effect, transportation costs, even if only over a short distance, effectively double the price many consumers in the developed world already pay. Like any commodity, doubling the price has a tangible impact on the amount the market demands. Unfortunately, unlike many other commodities, water has no substitute.

Furthermore, these estimates exclude the cost of purchasing the water itself. Unlike most commodities, the pricing mechanisms for water resources remain inconsistent and relatively untied to market forces.

Data from Credit Suisse show the considerable disparity in the cost of water between many developed countries. The price for water in Canada, the third-richest country in terms of annual renewable freshwater resources, is approximately 60% greater than the average price in the United States, a relatively water-rich country in its own right. But compared to many Europeans, Americans and Canadians pay relatively little for the water they consume. Yet, the more interesting takeaway has been the substantial price spikes in many industrialized countries that face little or no water scarcity (See Figure 6).

In fact, water rates in these countries have typically outstripped their countries' respective inflation rates by a considerable amount for much of the past 20 years. Credit Suisse estimates that this phenomenon stems from the fact that higher prices are required to maintain margins given rising costs of production. We expect this trend to continue.

figure 6. **2008 Water cost comparison**
Source: Credit Suisse research

Country	Cost (U.S.¢)/m³ 2008	5-Year Average % Change	5-Year Average CPI Rate	Relative Difference
U.K.	237.0	9.6%	2.1%	7.5%
Australia	181.5	17.3%	3.0%	14.3%
Canada	102.2	10.9%	2.2%	8.7%
South Africa	102.0	14.0%	5.6%	8.4%
U.S.	74.1	6.0%	3.0%	3.0%
Unweighted Avg.	**170.5**	**7.6%**	**2.4%**	**5.9%**

When accounting for the fact that consumers in emerging markets pay a fraction for their water compared to those in OECD member nations, the economics of exporting water across the globe seem tenuous at best. The inflationary impact on the regions' goods and services could be severe. In the end, as Fred Pearce, environment consultant of New Scientist magazine, succinctly points out, "The water business, like the property business, comes down to a matter of 'location, location, location.'"

The inability to economically transport water over long distances raises the specter of peak water. Investors are probably more familiar with the term "peak oil," an expression that refers to the point in time when the amount of oil extracted worldwide reaches a literal peak and begins a long-term decline. The concept is rather controversial. Some industry officials state that oil production cannot climb above 90-95 million barrels a day, 5-10 million barrels above current production, due to the geological characteristics of the world's reservoirs.

Others suggest that constraints on production growth are not so much a function of limited resources, but instead the result of limited resources existing within geopolitically friendly parts of the world. Either way, as demand begins to outpace available supply, the price begins to rise.

The concept of peak oil is now being applied to water. But unlike oil, water is a renewable resource. The total amount of water on earth is never in decline, but the amount of water in certain parts of the earth is in serious decline. The regions that face the most severe water scarcity (China, India and MENA) are also the regions that have historically relied on what is known as "fossil water." Fossil water is simply the water from wells that possess a very slow renewable recharge rate. With respect to the recharge rate, scientists estimate that much of the water took thousands of years to accumulate, making this particular water, like oil, effectively a non-renewable resource.

Although we lack the economic capacity to transport water over long distances, we can transport the agricultural or industrial products that require massive amounts of water in the production process. This idea of exporting "virtual water" from Iowa cornfields to markets overseas would certainly help alleviate shortages. Agriculture, which accounts for 70% of total water demand, places the most strain on the world's aquifers. But even water-rich regions like the United States must assess how much water-intensive agriculture it is willing to export. The Ogallala Aquifer, the vast underground reservoir that irrigates the majority of America's breadbasket, is currently being depleted faster than it can be recharged. According to the U.S. Geological Survey, this aquifer serves approximately 27% of the of the country's irrigated land, in addition to 1.9 million municipal users. Scientists estimate that it will take 6,000 years to refill at the natural recharge rate. Turning to aquifers like the Ogallala to feed the current population, much less the extra two billion mouths we expect to add over the next 15 years, does not appear to present a practical, long-term solution.

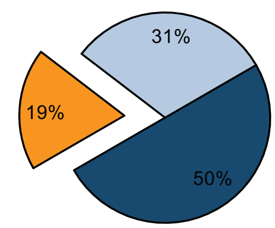
The concept of transporting virtual water to lessen the burden on industrial demand has its limits as well. For The regions with the lowest supplies also happen to be the regions with the lowest wage rates. Furthermore, a great deal of industrial demand (thermal power generation) must be located relatively close to its end user.

As Meena Palaniappan and Peter H. Gleick of the Pacific Institute note, "The idea of peak water, despite its flaws, is that it signals we are at the end of the age of cheap, easy water. In the same way that peak oil has meant the end of cheap, easy to access sources of petroleum, peak water means we are going to have to go further, spend more, and expect less in the realm of freshwater."

This will be especially true for emerging market economies. The countries most vulnerable to water scarcity are the same countries that now represent roughly half of the world's GDP measured at purchasing power parity (See Figure 7). More importantly, the bulk of their economic output is driven by water-intensive industries such as thermal power generation, steel, chemical and silicon chip manufacturing, as well as various petroleum, rubber and agricultural products. For agricultural and industrial output in these regions to continue to achieve high, sustainable growth rates, significant investments to secure water resources will have to become a top priority.

figure 7. **Economic growth fuels water demand**

Source: IMF 2008



Finally, we note that the current supply constraints addressed in this brief exclude the potential impacts of global climate change on water availability. Research suggest that global warming's affect on the world's water resources will only exacerbate the problem of uneven distribution.

The ultimate impact of climate change remains uncertain, even though changes to the hydrologic cycle are currently being experienced. The Intergovernmental Panel on Climate Change (IPCC) recently revised its ominous projections on Himalayan glacier melt, fueling speculation that water scarcity in Southeast Asia was being overstated. This miscalculation drew serious attention because seven of the world's largest rivers rely on Himalayan glacier ice for their annual flow. More than a billion people in the region rely on these rivers as the main source for their water supply. Regardless, we contend that glacier melt should be viewed as a potential catalyst for aggravating the problem, not the source of the problem itself.

Key Takeaways

- Long-distance transportation is not economically viable.
- Water has no substitute for a wide range of functions and purposes.
- For regions to continue to achieve high, sustainable growth rates, significant investments to secure water resources – from both the public and private sectors – must become a top priority.
- Current supply constraints addressed in this brief exclude the potential impacts of global climate change on water availability.

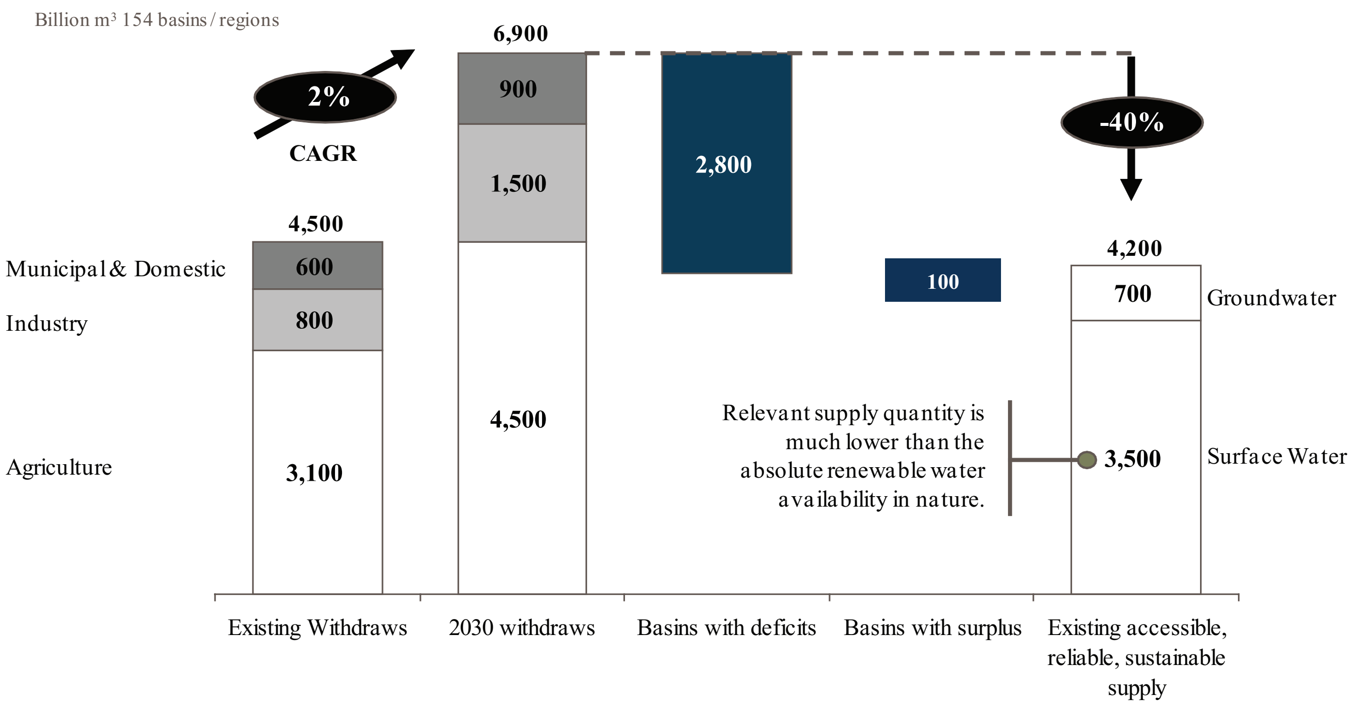
3. Please Mind The Gap

According to a 2009 McKinsey study entitled *Charting Our Water Future*, by 2030, under an average economic growth scenario, the demand for water will be 40% higher than current reliable, sustainable supply, assuming no efficiency gains (See Figure 8).

In developing countries, locations where the acute need is even greater, the deficit is larger than 50 percent. Without investment in efficiency improvements, global water demand is projected to grow at a 2% compounded annual growth rate over the next twenty years. By comparison, Exxon estimates energy demand to increase by 1.2 percent per year on average over that same period (See Figure 9).

figure 8. **Aggregated global gap between existing accessible, reliable supply and 2030 water withdraws, assuming no efficiency gains**

Source: Water Resource Group initiative, McKinsey, 2030 Water Resources Global Water Supply and Demand Model



For the three main user groups we highlight in this section – agricultural (which accounts for 70% of total water demand), domestic (8%) and industrial (22%) – the solutions will vary. Each user group faces a unique incentive structure that will serve to motivate their behavior in various ways. These incentives will impact the productivity, composition and timing of investment dollars going forward.

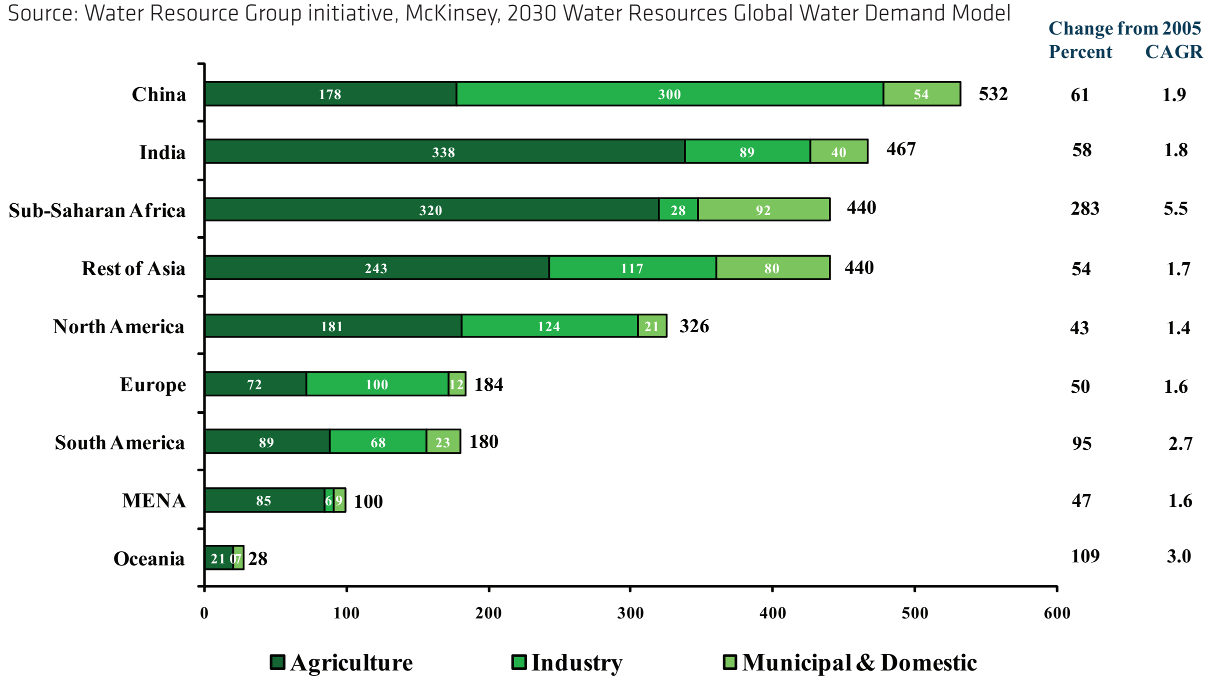
Although the focus of this brief has addressed the regions that face the greatest challenge, no region in the world is immune to this structural shift. As we capture in figure 9, the annual demand for water will either closely match or exceed the 1.2% annual growth in demand for energy through 2030.

3a. Municipal & Domestic

Historically, the public sector has provided the majority of water supply and sanitation services for municipal and domestic users. But unlike industrial commodities or electricity, water is traditionally seen as an "entitlement" for which "price" should not be defined by economic forces. The result has been a system where prices have been kept artificially low, effectively creating a subsidized utility in which private capital could not compete.

If the private sector were to assume a greater role in increasing water supply, there could be many ways to begin alleviating the gap between supply and demand. First, water tariffs that accurately reflect market rates should deter unnecessary waste. Second, the budgetary constraints of many over-leveraged or under-productive governments would benefit from outsourcing the capital

figure 9. **Increase in annual water demand 2005-2030**
Source: Water Resource Group initiative, McKinsey, 2030 Water Resources Global Water Demand Model

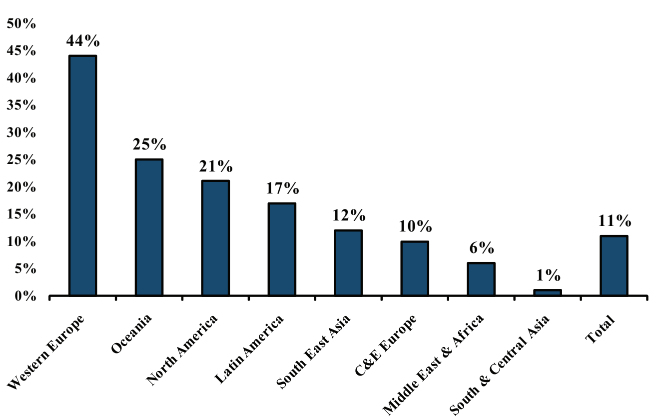


investment, operating and maintenance costs of new water treatment plants, wastewater treatment plants, water recycling plants and desalination plants. Finally, private participation would allow municipalities to benefit from the development and commercialization of new technologies and engineering capabilities.

Western Europe has fully embraced private sector participation. Forty-four percent of its water is currently delivered by private suppliers. Europe also pays significantly more for the water it consumes. North America has begun to incorporate more private sector participation as well, outsourcing a quarter of its production capacity to non-governmental entities. On the other end of the spectrum, the regions facing the greatest scarcity crisis rely on private sector participation the least (See Figure 10).

Rising prices could certainly go a long way towards incentivizing change. Some countries have already

figure 10. **Water supply: % of population served by the private sector, 2008**
Source: Credit Suisse research



begun moving in this direction. Water tariffs in China are up more than 27% since 2006. The same trend is taking place in parts of India as well. In Bangalore, water rates are set to rise in the range of 33% to 200%. But the deeper question is whether domestic users in water-scarce countries can accommodate rising prices.

As we can see from Figure 11, water prices as a percent of disposable income remain relatively low throughout Southeast Asia. Consumers in India and China, the countries that arguably face the greatest challenge, currently pay less than 1.5% of disposable income. Even under a baseline scenario of stagnant economic growth, we anticipate that consumers could absorb further rate hikes. Nonetheless, consensus forecasts for above-average growth rates going forward suggest that incomes throughout the developing world should continue to rise. Therefore, we remain confident that private participation in the development of water delivery and wastewater treatment systems for municipal and domestic users will continue to grow.

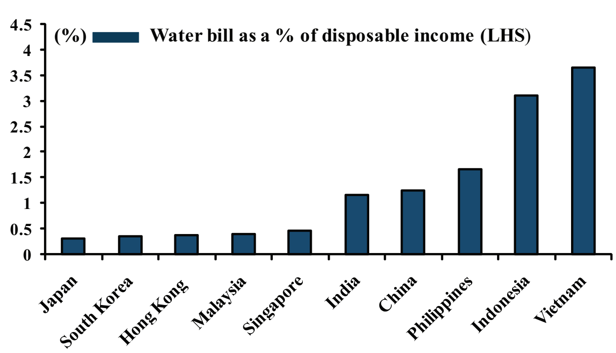
Unfortunately, politicians are generally disinclined to spend capital – political or financial – to avert future problems, no matter how serious those problems may actually be. Furthermore, existing government intervention in the form of economic subsidies and preferential allocation on behalf of municipal and agricultural users lead us to believe that the central tension between democratic cooperation and political self-interest will be too great in many cases. Even China, a command-driven economy that's known for decisive action on a national level, sometimes has difficulty instituting quick, broad change on the provincial level.

The political constraints that often lead to bureaucratic gridlock should only be enhanced by the poor financial state of many local governments. Ultimately, current conditions should open the door for private investment in water-related investments. Still, compared to most agricultural and industrial users, the incentive structure seems to imply that the probability for a sweeping, constructive overhaul remains highly unlikely.

3b. Agriculture

Today, agricultural uses more than 70% of all water withdrawals. The Food and Agriculture Organization estimates that in order to account for perdictions that the world's population is likely to rise by another two billion by 2025, the world will need as much as 60% more water for agriculture purposes alone to feed the extra two billion mouths. The amount of supply needed to meet this demand roughly equals the total water consumption in the world outside of Asia today. Therefore, maintaining the status quo is not an option.

figure 11. **Water affordability**
Source: CLSA Asia-Pacific Markets



As discouraging as this may sound, the key to closing the gap to a manageable level does not necessarily involve increasing supply or relocating agricultural production to water-rich regions with ample amounts of arable land. Improving efficiency (more crop per drop) through new forms of water management would make a significant difference.

There are two principal methods to improve water management in agricultural processes:

i: Efficient Irrigation

Drip irrigation, the most efficient form of modern irrigation, saves water and fertilizer by delivering water slowly to the roots of plants through a network of valves, pipes, tubing and emitters. This waste-reducing technique replaces a more common practice of flooding fields through a system of canals. Traditional flood irrigation, which is more common in less-developed regions, remains extraordinarily inefficient. Crops only absorb approximately 50% of the water deployed.

Unfortunately, drip irrigation is not suitable for closely planted crops such as alfalfa or cereal grains. The high capital costs can also limit its use to high-value crops or large, industrial farming enterprises. An alternative is sprinkler (spray) irrigation. It operates on a center-pivot system that traverses a circle in the fields. While an improvement from flood irrigation, a more "modern" substitute to the high-pressure, central pivot systems now exits. This option allows water to be gently sprayed downward onto plants instead of being shot high in the air. This method increases irrigation efficiency from about 60% (traditional spray irrigation) to over 90%.

ii: Drought-Tolerant Crops

Monsanto is working on its first-generation drought-tolerant corn, which it expects will provide farmers a 6 to 10 percent yield improvement in water-stressed conditions. It anticipates a potential 2012 introduction date, pending regulatory approvals. Management reports that the product has performed well in field trials and controlled tests in stress mitigation tents. **Syngenta**, an agribusiness involved in the discovery, development, manufacture and marketing of a range of products designed to improve crop yields and food quality, and Pioneer, a seed division of **DuPont**, have also begun work on drought-tolerant crops.

3c. Industry

Industrial demand accounts for the remaining 22% of all water withdrawals. Private companies use water in a variety of ways, including: cleaning, heating and cooling for generating steam in the power production process; for transporting dissolved substances or particulates; as a raw material; as a solvent; and as a constituent part of the product itself (e.g., in the beverage industry). As an industrial commodity, water often serves as a critical input in the production of a variety of goods. Therefore, in many cases, water risk equals business risk.

As members of The 2030 Water Resources Group, a variety of companies listed here are aware of the increasing business risks associated with this issue: **The Barilla Group**, a global food group; **The Coca-Cola Company**, a global beverage company; **Nestlé S.A.**, a global nutrition, health and wellness company; **SABMiller plc**, a global brewer; **New Holland Agriculture**, a global agricultural equipment company; **Standard Chartered Bank**, a global financial institution; and **Syngenta AG**, a global agribusiness.

As unconditional for-profit stakeholders in the queue for limited supplies, industrial users face the greatest risk of being the recipient of disproportionate allocation and rising costs.

Therefore, we expect that the ingrained profit/loss component for industrial users will add a greater incentive as population and income growth march ahead, while our finite supplies of water struggle to meet ever-growing global demand. These concerns have all contributed to a massive economic shift towards rapidly-growing, multi-billion dollar industries focused on finding solutions to promote efficiency gains that help reduce demand, as well as cost-effective technologies capable of increasing supply. As an example of what can be achieved, the **Dow Chemical Company** recently announced cooperative efforts with **Nalco**, a company that provides integrated water treatment and process-improvement services for industrial and institutional applications.

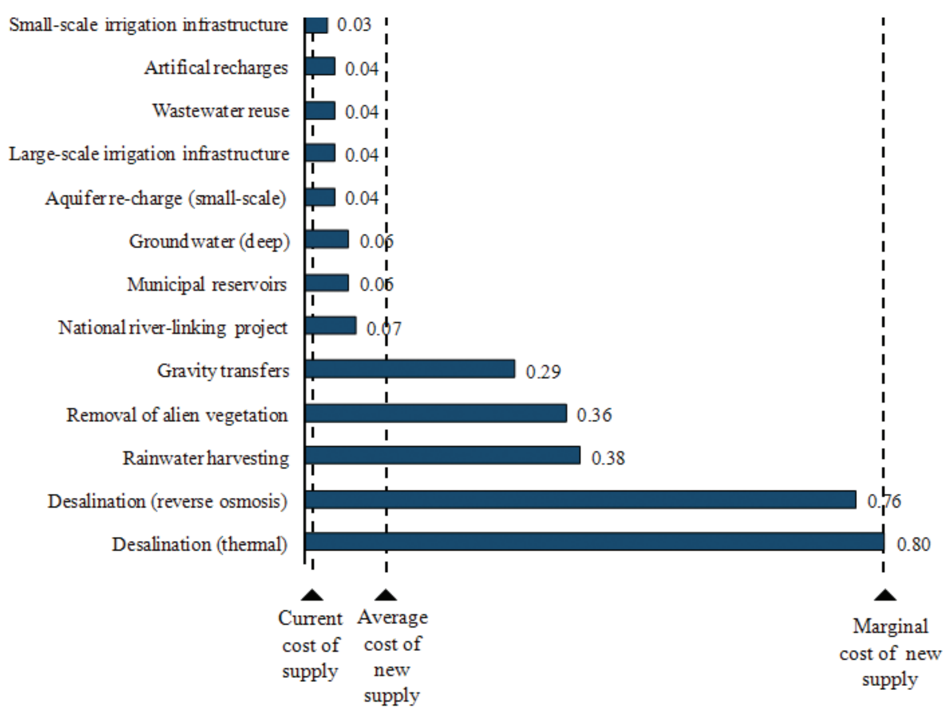
The venture has resulted in annual water savings of one billion gallons of freshwater at Dow's massive Freeport, Texas production site. The annual amount of water saved from this single industrial facility is enough to supply nearly 40,000 people in the U.S. for one year. According to the Company, these savings translate into a $4 million-per-year reduction in maintenance costs, reduced energy cost, reduced water use and reduced greenhouse gas emissions.

Many other companies have begun investing in water conservation. In an attempt to reduce water consumption by 20% per unit of production by 2015, **PepsiCo** commissioned the first wastewater reuse system within its Smith's snacks manufacturing facility in drought-stricken Australia. PepsiCo and Dow are two examples of key players in an extended business consortium actively focused on reducing their water footprint as a means of reducing business risk. For industries with value chains that are exposed to water scarcity, reducing this risk is not option, but rather an obligation. Consequently, investments like recycling systems and other technological solutions will only continue to rise.

Key Takeaways

- Without investment in efficiency improvements, global water demand is projected to grow at a 2% compounded annual growth rate over the next 20 years.
- The three main user groups face a unique incentive structure that will impact the productivity, composition and timing of investment dollars going forward.
- These concerns have all contributed to a massive economic shift towards rapidly-growing, multi-billion dollar industries focused on finding solutions to promote efficiency gains that help reduce demand, as well as cost-effective technologies capable of increasing supply.

figure 12. **Supply measures face a steep marginal cost curve**
Source: Water Resource Group initiative, McKinsey, 2030 Water Resources Global Marginal Cost Curve Model



4. Investment Implications

To alleviate the shortfall between supply and demand, McKinsey estimates that by 2016, the annual expenditure in the general water sector is expected to reach $770 billion, a significant increase to the $445 billion expenditure worldwide in 2005. This number includes capital and operating expenses that address the problem through a variety of upstream and downstream solutions. This study points out that the $770 billion estimate compares quite favorably to today's global expenditures in the natural gas sector ($770 billion annually) and electricity sector ($1.5 trillion annually). Going out to 2021, market consultants from Frost & Sullivan estimate the global market in water management – from treating sewage to desalination – to be $1.38 trillion.

There are two ways these investment dollars will work to narrow the gap: 1) increasing water supply through a combination of pipelines, desalination plants, recycling systems and other technological solutions; and 2) reducing demand, especially among agricultural users, by investing in technologies and infrastructure that focus specifically on better efficiency.

Desalination, traditionally the most expensive upstream solution, can now deliver a cubic meter of water for approximately $0.75-0.80, a figure on par with the average price in the U.S. today. Many countries are already turning to desalination technology as a viable solution. Global desalination capacity has grown by 55% over the past five years. According to Reuters, there are about 22,000 desalination plants in 120 countries, which together produce about 3 billion gallons per day.

The growth in desalination is not estimated to end anytime soon, especially as reverse osmosis (RO) membrane technologies reduce the costs even further. This should only incentivize countries with limited water resources to adopt this technology. In addition to removing salt, membrane filtration and purification technology should play significant roles in water treatment of all kinds.

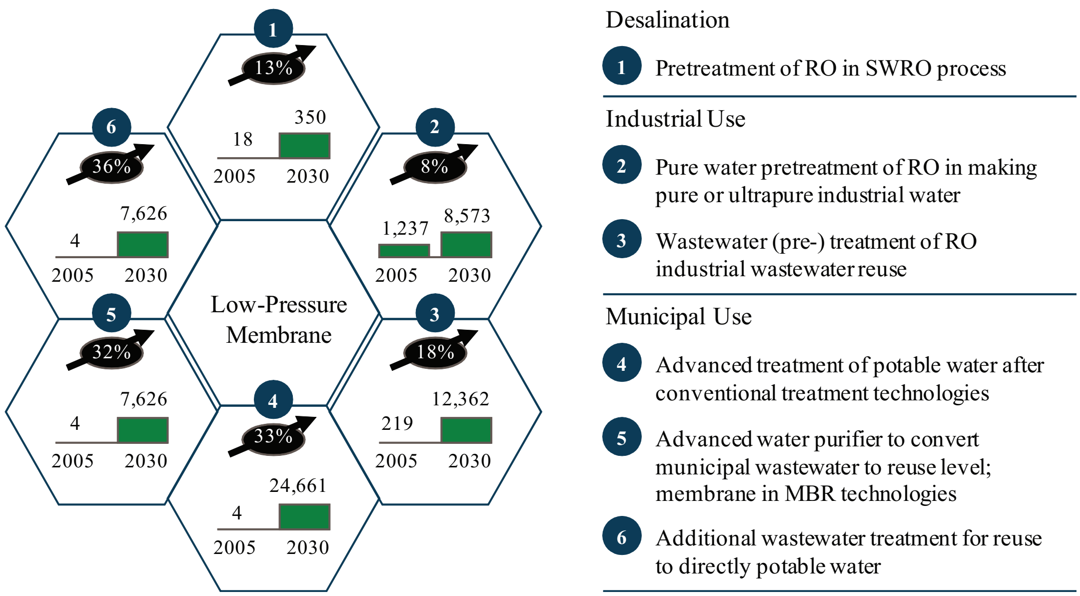
McKinsey points out that although this filtration method is still more expensive than traditional, more-prevalent bio-treatment technologies, it offers superior quality, making it particularly relevant for certain industrial and municipal users. Although adoption rates will invariably differ, McKinsey projects the Chinese market for low-pressure membranes will grow substantially over the next 20 years (See Figure 13).

Membrane technologies alone will not solve the problem. In other regions, especially those that face economic scarcity, infrastructure development in the form of pipelines, reservoirs and other supply-side solutions is essential.

From a demand perspective, the implementation of more efficient irrigation techniques and drought-resistant crop technology has the potential to deliver the greatest impact. Other technologies capable of detecting and locating leaks in water pipelines will be critical as well.

In the end, the approaches used to close the supply-demand gap will require contributions from a variety of private businesses. To help illustrate the variety of participants already working to provide solutions, we have included a partial breakdown of the S&P Global Water Index to help illustrate the relative depth within

figure 13. **Market size of low-pressure membrane by application**
Source: Water Resource Group initiative, McKinsey, 2030 Water Resources



the sector. The Index is comprised of 50 of the largest publicly-traded companies in water-related businesses that meet specific investability requirements. The index is designed to provide liquid exposure to the leading publicly-listed companies in the global water industry, from both developed markets and emerging markets.

All stocks in the investable universe are classified as being in one of the two clusters: Water Equipment Instruments & Materials or Water Utilities & Infrastructure, and are defined as follows (See Figure 14):

figure 14. **S&P Global Water Index construction**
Source: S&P

Water Equipment & Materials	Water Utilities & Infrastructure
Water Treatment Chemicals	Water Supply
Water Treatment Appliances	Water Utilities
Pumps & Pumping Equipment	Waste Water Treatment
Plumbing Equipment	Water Purification
Plumbing Pipes	Water Well Drilling
Fluid Power Pumps & Motors	Water Testing
Totalizing Fluid Meters & Counting Devices	Water, Sewer & Pipeline Construction

In closing, we believe that the case for investing in businesses – both new and existing – that seek to provide solutions to this challenge has never been stronger. We note that by comparison, the S&P Global Water Index has outperformed by S&P 500 Index for each of the one–, five–, and ten-year holding periods ending December 2009 (See Figure 15).

At the very least, we hope the information presented in this report provides readers with a different perspective on the single resource that arguably, but unknowingly, shapes our daily lives more than any other. According to the Red Cross, more than one billion people do not have access to clean water. Roughly one out of every three people on earth lacks access to adequate sanitation facilities. The consequences of these circumstances are dire. Water-related diseases claim the lives of four million people each year. But within every challenge there exists an opportunity. In the end, closing the supply-demand gap for the world's water resources will not be a question of if, but rather a question of how.

figure 15. **Index performance – December 2009**
Source: S&P

		S&P Global Water Index	S&P 500 Index
Annualized Returns	1 Year	32.67%	24.46%
	3 Years	-2.33%	-5.63%
	5 Years	9.12%	0.42%