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SAM Study

Water: a market of the future

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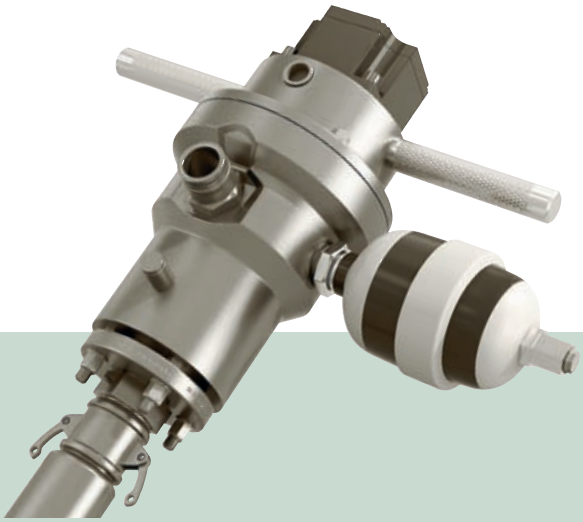
Daniel Wild
Marc-Olivier Buffle
Junwei Hafner-Cai

member of ROBECO



WAVEFRONT INJECTION TECHNOLOGY FOR GROUNDWATER REMEDIATION

This innovative technology is used to clean up hazardous waste sites that contaminate groundwater by broadly distributing remedial fluids throughout the aquifer. It reduces remedial costs by more than 40 percent.

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Executive summary

Supplying water of adequate quality and in sufficient quantities is one of the major challenges facing modern society. In many countries the available water reserves are now being overexploited to such an extent that the negative consequences can no longer be ignored. Countries located in arid regions are finding it particularly difficult to irrigate the crops they need to feed their population. At the same time many people still do not have access to safe drinking water, because water resources are limited or polluted by domestic and industrial wastewater.

The situation will become even more critical in the years ahead. Four megatrends are shaping the development of the water market:

- **Global population growth.** Demand for water is soaring, and not just to cater for the personal needs of individuals. In the coming years even more water will be needed to produce food for the world's burgeoning population.
- In many countries the **infrastructure** for supplying the population with drinking water and wastewater treatment is badly run down. Major investments will therefore be required in the short term to upgrade aging water mains and sewer systems in particular.
- Higher standards for **water quality.** One major priority is to ensure that people living in developing and newly industrialized countries have access to clean drinking water. In addition, solutions need to be found to meet the fresh challenges arising from new micropollutants that are becoming a problem in industrialized countries, in particular.
- **Climate change** will cause significant variations in the hydrological regime in many regions, culminating in a water crisis in some areas.

Many people do not have access to safe drinking water, because water resources are limited or polluted by domestic and industrial wastewater.

These megatrends will intensify the pressure to manage existing water resources far more efficiently in the years ahead. The associated investments will inevitably have an impact on the markets in question. This situation opens up attractive opportunities to all businesses offering products and services for the treatment, supply or use of water. Those companies that are capable of offering sustainable solutions stand to benefit the most. Based on an analysis of the current situation and an assessment of future market demand, SAM has identified four investment clusters that promise attractive upside potential:

- **Distribution and management:** Companies active in this cluster offer solutions for upgrading water mains and sewer infrastructure, develop systems for supplying freshwater and removing wastewater, act as utilities, or are involved in the management of water resources.
- **Advanced water treatment:** This cluster includes companies that play a key role in the disinfection of drinking water, the treatment of wastewater or the desalination of seawater, or which provide the necessary control systems and analytical instruments.
- **Demand-side efficiency:** This cluster includes companies offering products and services that boost the efficiency of water use in households or industry.
- **Water and food:** Companies in this group develop products that improve water efficiency and reduce pollution in crop irrigation and food production.

As the overall social, economic and environmental climate changes, corporate sustainability has become an increasingly crucial success factor. This study lays the foundation for an attractive and all-inclusive investment strategy that is geared toward the sustainable development of the water industry.

1 WATER – A GLOBAL CHALLENGE

1 Water – a global challenge

1.1 A KEY ROLE IN OUR FUTURE

Water is essential for life. We need water for everything: for our personal use, in order to grow food, and to produce virtually all the goods required for our daily existence. It is impossible to imagine our lives without an adequate water supply.

Yet water is not just a life preserver: it can destroy life as well. It can spread waterborne infectious diseases for example. Millions of people worldwide suffer from serious diseases because they do not have access to clean drinking water.

Water is also vital for economic prosperity. The sale of water-related equipment and services is now a business with an annual turnover of over USD 480 billion. Although water has become a precious commodity in many areas of the world, the price of water charged to consumers in most countries is still too low to accurately reflect its value.

Economic importance steadily growing

Over the coming years the economic importance of water will continue to increase for a number of reasons:

- Global demand for water is soaring. To meet this demand, a whole range of water services needs to be expanded and made to operate more efficiently.
- To meet the current challenges, enormous investments are required to upgrade and expand the water infrastructure.
- For poorer and rapidly growing nations in particular, new technologies need to be developed for treating, distributing and using water.
- It is unlikely that water can be made available for all applications in the future at the same low cost as it is today. If the price of water does increase due to supply bottlenecks, this will have dramatic consequences for all areas of our lives that essentially depend on water. These areas include virtually all of society's commercial activities, from agriculture through to the production of everyday consumer goods.

Companies that identify these changes at an early stage and subsequently take steps to exploit the resulting opportunities will be better positioned in the market and will achieve greater commercial success.

1.2 SUPPLY AND DEMAND

There are two dominant features in current global water consumption patterns:

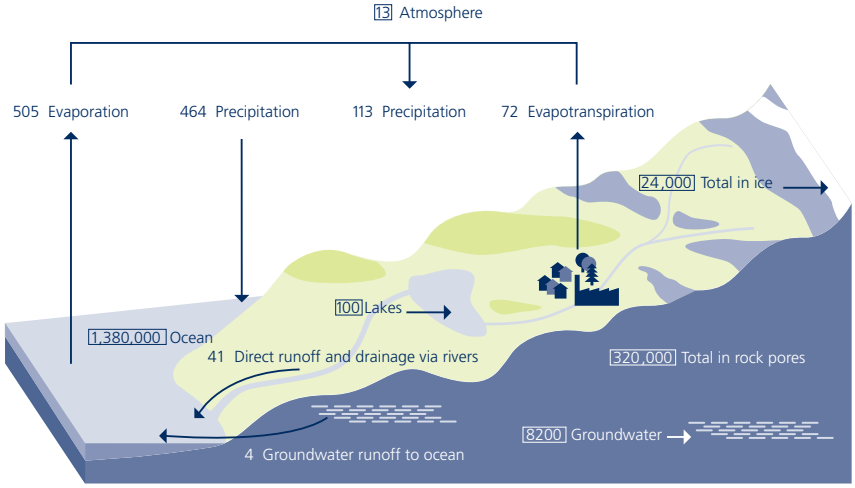
- The supply of freshwater is limited, but demand is growing steadily.
- Many countries are failing to satisfy the basic need to provide sufficient quantities of water of acceptable quality.

Limited water reserves

Every year about 90,000 to 120,000 km^3 of precipitation falls on the world's continents and islands. About two-thirds of this precipitation reverts directly to the atmosphere through evaporation. Of the remaining 35 percent, two-thirds flow into watercourses and is not fit for human use. A total of some 9000 to 12,000 km^3 of water is therefore available for drinking, agricultural irrigation and industrial use.[1]

[1] Zehnder, A.J.B.; Schertenleib, R.; Jaeger, C.: Herausforderung Wasser. EAWAG Jahresbericht, 1997.

Figure 1: Global water cycle
The figures in boxes represent the reservoirs of water (in 1000 km³), while the others show water flows (in 1000 km³ per year).
Source: Zehnder, A.J.B.; Schertenleib, R.; Jaeger, C.: Herausforderung Wasser. EAWAG Jahresbericht 1997.



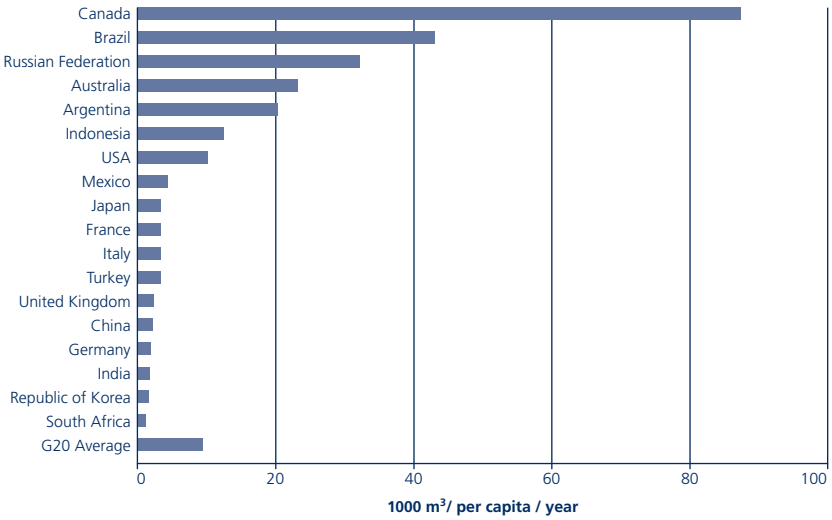
Conversion table
1 km³ = 1 bn m³
1 m³ = 1000 l
1 ha = 10,000 m²

However, there are significant regional differences in the distribution of the effectively usable water.[2] In countries with ample rainfall, such as Switzerland, more than 7000 m³ of water are available per person per annum. In arid regions however, sometimes only a few hundred cubic meters are available per person per annum. One worrying trend is the sharp decline in the quantity of water available to each person in many countries in recent years. The situation is especially critical in low rainfall countries.

Demand continues to rise

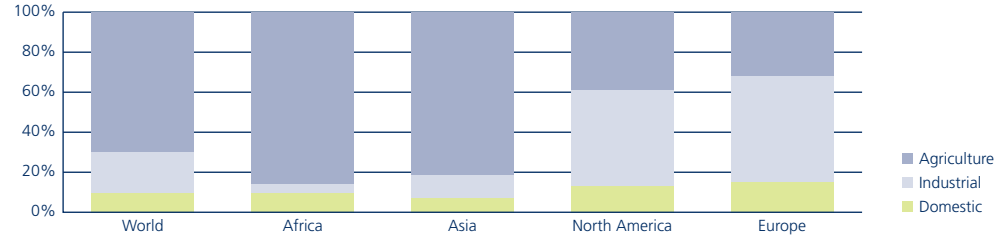
Water use can be roughly divided into three areas: urban water management, agriculture and industrial production. Worldwide, 10 percent of water flow into domestic use, 70 percent into agriculture and 20 percent into industrial production. There are, however, major regional differences in water use: In developed countries, about half the water consumption is destined for industrial uses, whereas in developing countries, agriculture is the biggest consumer of water, at about 80 percent.

Figure 2: Per capita renewable water resources
India's annual per capita renewable freshwater availability is less than 2000 m³, significantly below the G20 average of 9400 m³
Source: Responsible Research: Water in China, 2010.



[2] UNESCO: Water – a shared responsibility. The United Nations World Water Development Report 2, 2006. www.unesco.org/water/wwap (5.10.2007).

Figure 3: Water use in different regions
Source: FAO: Aquastat. www.fao.org/nr/water/aquastat (5.10.2007).

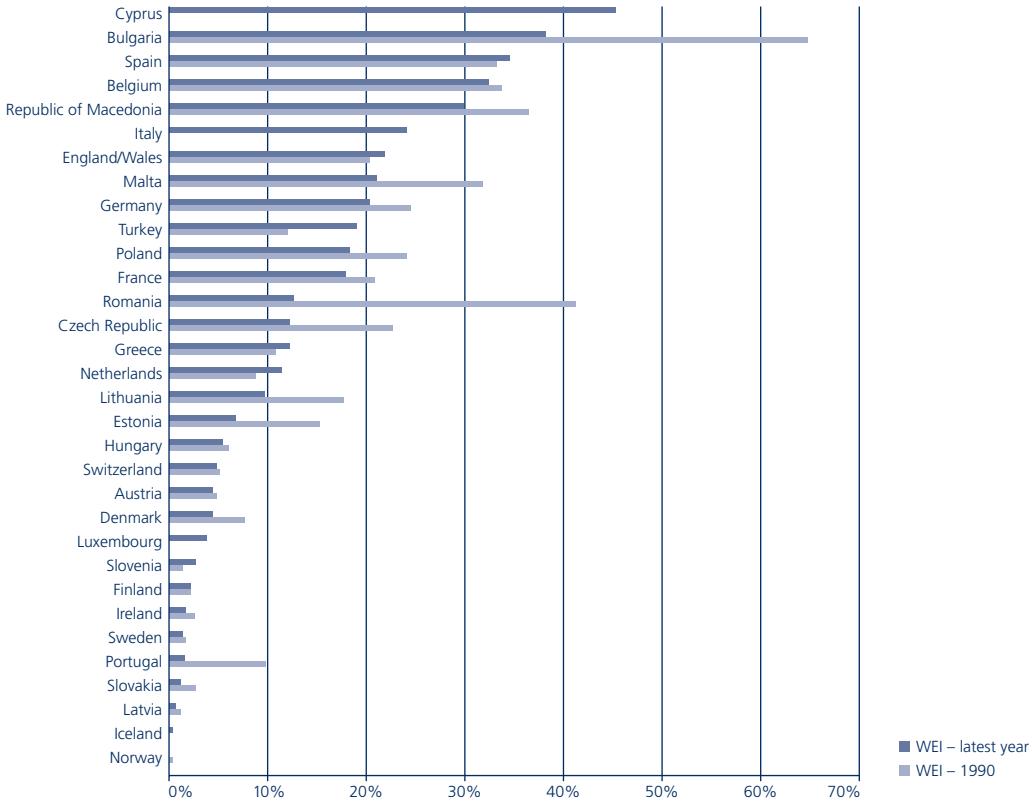


Overall, water consumption has risen sharply in recent decades. In 1900, annual water extraction volumes totaled approximately 770 km³. By the middle of the century, this figure had doubled to 1480 km³. Current consumption is estimated at 4500 km³.[3]

This trend is likely to continue in the coming years, with consumption surpassing 6500 km³ in 2030. The extra demand can be explained by relentless population growth as well as higher per capita consumption due to improved living standards.

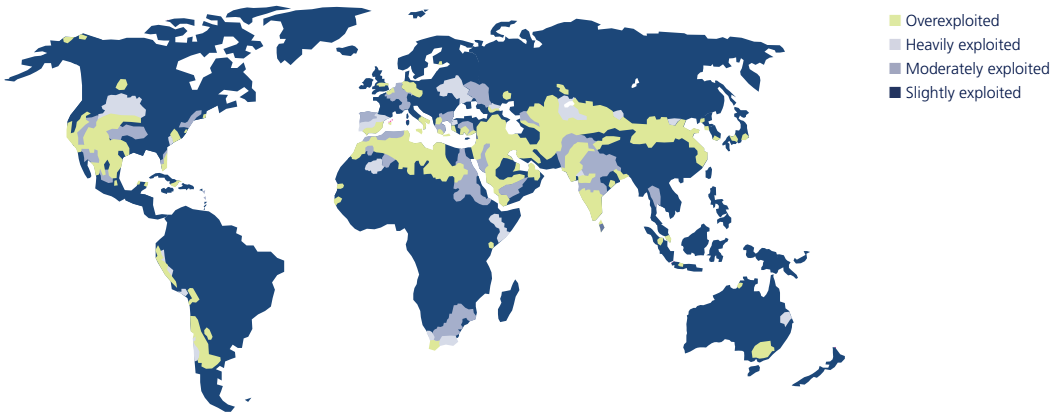
Water shortage is already a serious problem in many regions of the world, including southern Spain, the Maghreb, the Middle East, Central Asia, Pakistan, Southern India and Northern China. In the Americas, the U.S. Midwest, Mexico and the Andes are the worst-hit areas. Eastern Australia is also badly affected by drought.

Figure 4: Water Exploitation Index (WEI) for European countries
The Water Exploitation Index (WEI) specifies the percentage of renewable water resources consumed. If it moves above the 20% threshold, this is an alarm signal. Countries with a WEI of more than 40% suffer from extreme water shortage.
Source: European Environment Agency: EEA Signals 2009 Climate Change Adaptation: Water and Drought.



[3] 2030 Water Resources Group: Charting our Water Future, 2009.

Figure 5: Use of water reserves in different regions of the world
The map shows the river basin areas where the available water reserves are being overexploited by humans. In these regions, the long-term survival of the ecosystems is under threat.
Source: UNDP: Human Development Report, 2006.



Countries such as Yemen, Uzbekistan and Israel are currently consuming more water than can be replenished by natural means. China and India are also heavily exploiting their available water resources.

Countries such as Yemen, Uzbekistan and Israel are currently consuming more water than can be replenished by natural means. China and India – the two countries with the largest populations – are also heavily exploiting their available water resources.

The availability of water in individual countries is measured by the Water Exploitation Index (WEI). This index records water consumption as a percentage of annually renewable water reserves. A WEI of 20 percent is a critical value that signals the beginning of a water shortfall. Nine countries in Europe – Belgium, Bulgaria, Cyprus, Germany, Italy, Macedonia, Malta, Spain and the UK (England and Wales) – have a WEI of more than 20 percent. Countries with a WEI of more than 40 percent suffer from extreme water shortages and no longer use their available reserves in a sustainable way.

But there are also some regions where the situation has improved. This is particularly the case in Eastern Europe, where water consumption has dropped significantly since 1990, mainly thanks to infrastructure improvements and more efficient use of water.

Private consumption: Water brings prosperity

An average European uses between 150 and 400 liters of water every day for his personal requirements. Consumption in the U.S. is almost twice as

Figure 6: Water use and global population 1900–2025
A comparison of global water consumption since 1900 and predicted water consumption up to 2025 against global population trends demonstrates that water consumption has increased more rapidly than the overall population.
Sources: FAO: Aquastat, www.fao.org/nr/water/aquastat (5.10.2007); United Nations Secretariat: The World Population Prospects, 2006.

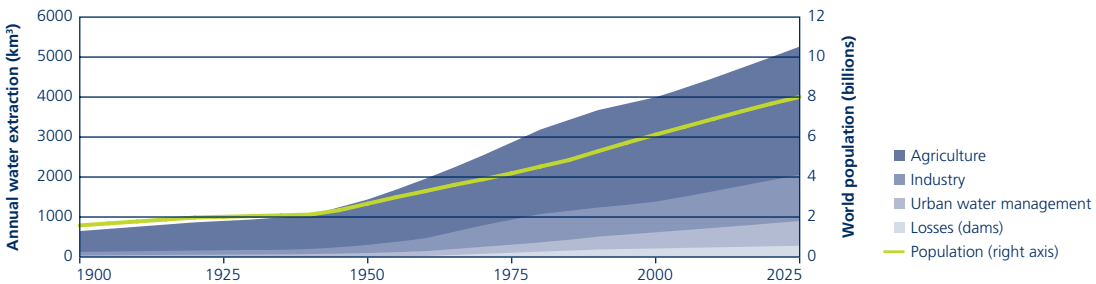
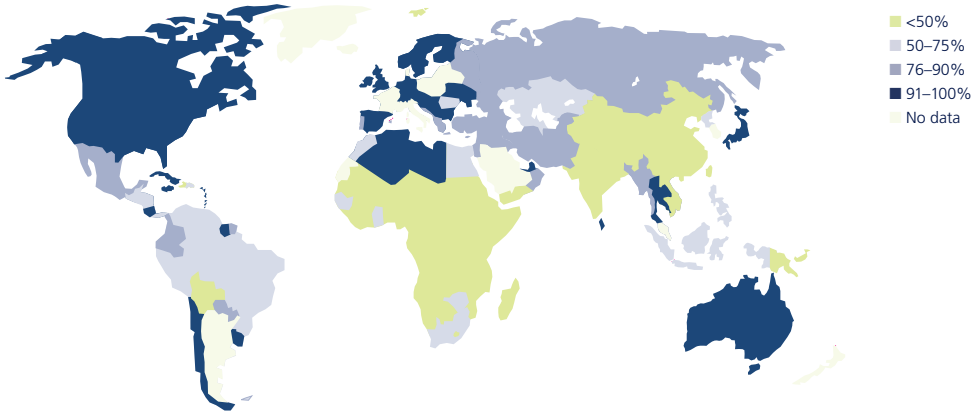


Figure 7: Percentage of the population with access to sanitation
Source: UNDP: Human Development Report, 2006.



high, at 580 liters per persons per day. In China, by contrast, the figure is only 90 liters per day on average. In many developing countries, individual consumption is well below the limit of 50 liters per day specified as the critical threshold by the Food and Agriculture Organization (FAO).[4]

In many countries, wastewater is not adequately treated (or not treated at all) before being channeled back into the water cycle. These countries therefore have to cope with undesirable impacts on human health and the environment. About 2.4 billion people worldwide have no access to adequate sanitation. The situation is particularly critical in Africa, Southeast/Central Asia and parts of South America.[4]

Countries with an efficiently run urban water management system have invested large sums in their infrastructure in recent decades. In Switzerland, the specific repurchase value of the entire public and private sewer system, along with all the wastewater treatment facilities, comes to almost CHF 100 billion. This works out to CHF 13,600 per head of population.[5] Many of these installations are now decrepit, and need to be replaced within the next few years.

Agriculture: The major consumer

Agriculture is easily the world's heaviest consumer of water, most of which is used for irrigation. It takes about 2500 kcal per day to meet one adult's energy requirements. One kilogram of bread contains about 3500 kcal, and it takes roughly 1000 liters of water to produce this bread under optimum growing conditions. Based on this assumption, it takes about 260 m^3 of water to feed one person for one year with a vegetarian diet.

The more meat contained in a person's diet, the higher the associated water consumption. Where meat accounts for 20 percent of a person's diet, twice as much water is consumed for its production.[6] This calculation does not take into account the fact that conditions for food production are seldom ideal. Much of the water used is wasted due to crop failures and losses in irrigation. If production losses are factored in as well, it takes 550 m^3 of water to provide one person with a purely vegetarian diet for one year.

Because rainfall is distributed so unevenly, not all countries are able to produce enough food for their own population. Many governments therefore have to resort to importing food, which in some cases accounts for up to 35 percent of all imports.

[4] UNDP: Human Development Report, 2006.

[5] Herlyn, A.: Status quo der Schweizer Abwasserentsorgung. Gas Wasser Abwasser 3, 171-176, 2007.

[6] Zehnder, A.J.B.; Schertenleib, R.; Jaeger, C.: Herausforderung Wasser. EAWAG Jahresbericht, 1997.

Table 1: Water quantities used in food production
Volume of water (in liters) needed to produce 1 kg of the food specified.
Source: UNESCO – IHE: http://www.waterfootprint.org (5.10.2007).

	Liter
Beef	15,500
Lamb	6100
Pork	4800
Goat	4000
Rice	3400
Soybeans	1800
Wheat	1300
Corn	900

Not all countries are able to produce enough food for their own population. Many governments therefore have to resort to importing food, which in some cases accounts for up to 35 percent of all imports.

The situation becomes even more critical for these countries if food prices are forced higher by adverse weather conditions or competition from biofuel production. It is perhaps surprising to find that arable farmland registered only an insignificant increase worldwide in the period from 1960 to 2000. As a consequence, the area of cropland required per person fell from around 0.45 to 0.23 hectares from 1960 to 2010.

This reduction has been achieved through massive intensification of farming methods. This has included not just the use of fertilizers and crop protection agents, but also crop irrigation. A total of 275 million hectares of land is now under irrigation, equivalent to over 20 percent of the total area under cultivation.[7]

Industry: Consumption stabilized at a high level

Water also plays a crucial role in industrial production, whether it be for paper production, tire manufacture, electricity generation, mining or oil exploitation. In Europe, industry accounts for just over half of water consumption, while in the U.S. the figure is just below 50 percent.

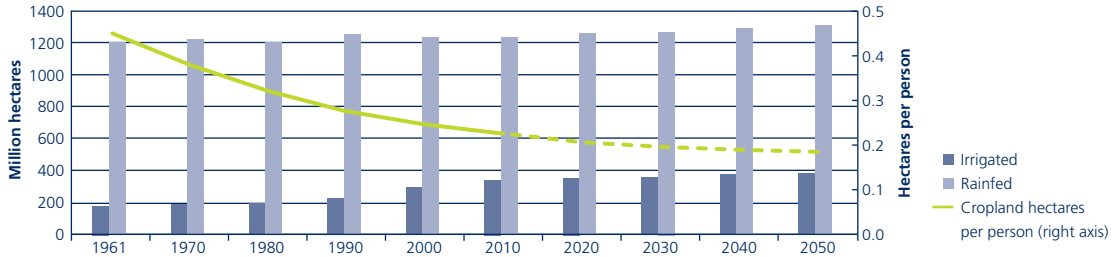
In contrast to agriculture and urban water management, where consumption is steadily rising, the situation is slightly more positive for industrial water use. Global water consumption by industry rocketed from about 150 km³ per year in 1950 to over 800 km³ in 1990.[8] Since then, industrial water consumption has continued to rise worldwide, but at a much slower pace than in previous decades. Industrial water withdrawal is projected to be 1500 km³ in 2030.[9] At the same time, there are significant regional differences. In Europe and North America, industrial water consumption after 1980 settled at about 200 km³ per annum (Europe) and 300 km³ per annum (North America). In Asia, the water consumption by the industrial sector is still increasing every year.

[7] UNESCO: Water in a Changing World. The United Nations World Water Development Report 3, 2009.

[8] UNESCO: Water – a shared responsibility. The United Nations World Water Development Report 2, 2006. www.unesco.org/water/wwap (5.10.2007).

[9] 2030 Water Resources Group: Charting our Water Future, 2009.

Figure 8: Cropland per person trends
It is interesting to note that the cropland per person figure has dropped sharply.
Sources: United Nations Secretariat: World Urbanisation Prospects: The 2007 Revision Population Database; SAM.



2 GLOBAL TRENDS
IMPACTING THE WATER MARKET

2 Global trends impacting the water market

The global crisis threatening the management of water resources is likely to intensify in the coming years. Four trends are shaping the future development of the water sector:

1. Demand for water is increasing further as a result of demographic changes.
2. In many cases, the aging water infrastructure needs to be replaced.
3. Water quality improvements are necessary in many places.
4. Climate change is altering the availability of water resources.

2.1 DEMOGRAPHIC CHANGES

There are three ways in which demographics are affecting water consumption:

- The world's population will continue to grow in future decades.
- More and more people are moving from the countryside to towns.
- General living standards are improving, especially in the two countries with the largest populations China and India.

Continuing boom in global population

The world's current population of approximately 6.8 billion people will continue to swell over the coming decades. The UN predicts a global population of 9.2 billion people by the year 2050. Demand for water will of course escalate purely in response to this population growth. Experiences in recent decades even show that water consumption has grown at a faster rate than the general population. This trend is mainly attributable to continuous improvements in living standards. In 1950, per capita annual water consumption averaged 580 m^3. This figure had already risen to 660 m^3 by the year 2009. Given the improving living standards in regions such as Asia, in particular, this underlying trend is unlikely to be reversed for some time.

Increasing urbanization

Rapid population growth is occurring in tandem with increasing urbanization. More and more people are moving from the country to the city, usually because of a real or perceived lack of employment opportunities in rural regions. The urbanization trend is clearly reflected in the number of megacities. In 1950 there were only 86 cities with a population of more than 1 million, but this figure rose from 387 to 431 cities between 2000 and 2007.

The number of megacities is increasing rapidly in Asia, Africa and Latin America, in particular. The cities are growing not just in number, but also in size: In 2007, the world's 100 largest cities had an average population of more than 7 million people.

UN forecasts indicate that almost 60 percent of the world's population will be living in urban areas by 2030. The proportion is roughly 50 percent at present, compared with 29 percent in 1950. Rapid growth of cities creates a huge challenge for the water sector. Demand for water services, especially for wastewater treatment, is booming. Extending basic sanitation will require huge investments in the coming years. Over the next 5 years, approximately an additional 880 million people will require access to improved drinking water sources and approximately 1.4 billion will need to be connected to proper sewage treatment facilities in order to meet the 2015 Millennium Development Goals (MDG) targets.[10]

[10] United Nations: The Millennium Development Goals Report, 2009.

Table 2: Demographic trends and urbanization of global population
Sources: UN Population Division Department of Economic and Social Affairs: The Urban Agglomerations 2007; SAM.

No. of cities >1 million inhabitants	1950	2000	2007
World	86	387	431
Africa	2	35	42
Asia	31	194	218
Europe	30	62	63
Latin America	7	49	54
North America	14	41	46
Oceania	2	6	8
Average size of world's 100 largest cities (1000 inhabitants)	2200	6300	7000
% of population in urban areas	29	47	50
World population (million inhabitants)	2530	6125	6600

Drinking water target on track

The world seems to be on track to meet the MDG drinking water target, even though some countries face enormous challenges, especially in Sub-Saharan Africa. While water supply goals seem achievable, it appears that the MDG sanitation target will be difficult to reach.

Soaring demand for food

The rise in the world's population and the improvement in living standards are also having an impact on food production. The FAO expects demand for food to be 55 percent higher in 2030 than in 1998. Food production must increase by 1.4 percent per annum in order to meet this demand. The surge in demand will be driven mainly by developing countries. Intensifying the farming methods used in these countries should help to meet most of the increased demand for food. The FAO expects the overall area under

cultivation to expand. At the same time, the amount of cropland under irrigation is likely to increase by 20 percent. This will in turn push up water consumption by 14 percent, potentially causing local bottlenecks in areas such as the Middle East and North Africa, where there is likely to be less water available for agricultural use. These countries will therefore be forced to import even more food than at present.

UN forecasts indicate that almost 60 percent of the world's population will be living in urban areas by 2030.

Overexploitation of resources

The consequences of overexploiting water resources are already manifesting themselves in different parts of the planet. Once mighty rivers now carry only a fraction of their former water volume, and the groundwater table is steadily falling. Eleven countries accommodating almost half the world's population – including China, India, Pakistan, the U.S., Israel, Egypt, Libya and Algeria – currently have a negative groundwater balance.[11]

Overexploitation of water has dramatic consequences at local level:

- In the region around the Spanish city of Huelva the water table has been steadily falling for some years because many farmers illegally siphon off water to irrigate their fruit crops. This overexploitation is posing a threat to the Doñana national reserve in particular, which contains one of the most important marshlands in Europe.[12]
- On occasion, China's second-largest watercourse, the Yellow River, does not even reach the sea, or peters out into no more than a stream.[13]
- In the southern Indian state of Tamil Nadu, the expansion of agriculture has led to a situation where the Kaveri river, once 300 m wide, dries up on occasion. In some places the water table has fallen between 300 and 400 m.[11]
- Farmers in the southwest of the U.S. are feeling the effects of the overexploitation of groundwater: The level of the Ogallala aquifer, the world's third-largest underground water table, has fallen several meters in recent years. This has caused many fertile regions to dry out. Many farmers have had to revert to more basic crops, which generate less income. Although the size of the irrigated area has shrunk again, it will take only another 20 to 30 years before the Ogallala aquifer dries up completely.[11]

In view of these problems, some countries have plans for large-scale canal systems to divert water and alleviate the shortage in arid regions. India has launched a river-linking project to combine 14 rivers

[11] Lanz, K.: Wem gehört das Wasser? Lars Müller Publishers, 2006.

[12] Reye, B.: Knallrote Früchte mit üblem Beigeschmack. Tages-Anzeiger, 2007. www.tagi.ch (5.10.2007).

[13] Den Flüssen den Weg weisen. Neue Zürcher Zeitung, 2006. www.nzz.ch (5.10.2007).

Table 3: Major water transfer projects
Source: GWI: Global Water Market 2011, 2010.

Country	Project	Capacity (million m³/day)	Capital cost
Libya	Great Man-Made River	6.5	USD 11 billion
China	South to North Water diversion	110	USD 58 billion
Spain	River Ebro diversion	2.9	EUR 18 billion
Kuwait	Karun transfer (from Iran)	0.75	USD 2 billion
Jordan	Disi Amman Water Conveyor	0.27	USD 950 million

flowing from the Himalayas with rivers from the south. China has started work on a huge project to divert water away from the Yangtze into the arid regions of the north at estimated investment costs of over USD 60 billion. And Spain also has plans for channeling water from the north to the south. One common thread of these numerous projects is that they are often a source of public controversy and are bound to have serious consequences for the environment.

Tapping into new water sources

Although the water supply infrastructure is in a very dilapidated state in many countries, with large volumes of water being wasted through leakage, countries where water is scarce are increasingly trying to expand freshwater supplies through the use of desalination plants. The installed capacity of these plants has increased enormously in recent decades.

In 1970, the amount of water desalinated globally per day was less than 0.8 million m³. This figure has now increased to well over 59 million m³ per day in 2009. There is no sign of this trend abating, given that newly installed capacity is constantly increasing.

There are now over 14,000 desalination plants online, with other 244 known to be under contract or in construction, which represent an additional capacity of 9.1 million m³ per day.[14]

One reason for the boom in desalination plants is that production costs have dropped dramatically in recent years. Especially for plants using reverse osmosis membrane technology, operating costs are now 3 to 4 times lower than they were 30 years ago. With production costs of less than USD 1 per cubic meter of water, these plants are achieving price levels that are getting much closer to conventional water sources.[15]

One reason for the boom in desalination plants is that production cost has dropped dramatically in recent years.

Saudi Arabia is already the world's largest producer of desalinated water with 1420 online plants providing for a total capacity of over 10 million m³ per day.[16] One of the largest projects is a 1 million m³ per day plant at Ras Azzour.

Israel continues to expand its desalination and water recycling programs and has planned projects including the Red-Dead Sea Canal. The project is a 180 km aqueduct consisting of tunnel and channel sections, which would carry 1.8 billion m³ of seawater from the Red Sea to the Dead Sea area

[14] The International Desalination & Water Reuse Quarterly industry website, http://www.desalination.biz/news/news_story.asp?id=5121 (08.11.2009).

[15] Pacific Institute: Desalination, With a Grain of Salt – A California Perspective, 2006.

[16] GWI: Global Water Market 2011, 2010.

each year. Of this total, 800 million m³ would be desalinated to use as drinking water for Israel, Jordan and the Palestinian Authority, and 1 billion m³ a year would be pumped into the Dead Sea, which has been drying up.

Apart from facilities to desalinate seawater and brackish water, plants are also being built that are capable of treating wastewater for reuse in other applications. California's Orange County Water District and Orange County Sanitation District together have invested approximately USD 481 million in a water supply project to expand the county's water purification and seawater intrusion barrier facilities, as well as to install a 13-mile pipeline along the Santa Ana River for the reuse of advanced treated wastewater. The reuse of treated wastewater helps Orange County recharge its groundwater basin, protecting it from further degradation due to seawater intrusion. This represents a more cost-effective and energy-efficient solution, compared to importing water from northern California.[17]

2.2 AGING INFRASTRUCTURE

In contrast with many developing countries, where many people still do not have adequate access to safe drinking water, industrialized nations originally built their water mains back in the early 20th century. In many areas huge investments are now required in order to repair and upgrade the aging infrastructure. Water supply and sewer systems have a service life of roughly 60 to 80 years and in many cases have reached the end of their useful lives. Furthermore the water mains are not being adequately maintained in some countries:

- The standard of maintenance for the U.S. water mains and sewer system – like many other areas of the infrastructure – is far too low. Leaking pipes mean that large volumes of precious drinking water are wasted. The City of San Diego, for example, buys in 300 million m³ of water every year, 25 million m³ of which are never actually used, costing the city approximately USD 22 million.[18] The total water loss nationwide is probably in the region of 23 million m³ per day, which is equivalent to the combined water consumption of America's 10 biggest cities.
- The U.S. Environmental Protection agency EPA has identified a huge financing gap for the maintenance of drinking water and wastewater treatment facilities over the next 20 years: If spending continues at the current level, the total gap by the end of that period will amount to some USD 540 billion. Even if investments rose by 3 percent per annum in real terms, the shortfall would still come to USD 76 billion.[19]

[17] Groundwater Replenishment System Progress Report, 2008.

[18] Davis, R.: The case of San Diego's vanishing water, 2007: http://www.awwa.org/publications/MainStreamArticle.cfm?itemnumber=29525 (5.10.2007).

[19] U.S. EPA: Clean Water and Drinking Water Infrastructure Gap Analysis Report, 2002.

Figure 9: State of the US water supply system
If the standard of maintenance of the water supply system continues at its current level, more than half of the pipework will be in a poor condition or worse by 2020.
Source: U.S. EPA: Clean Water and Drinking Water Infrastructure Gap Analysis Report, 2002.

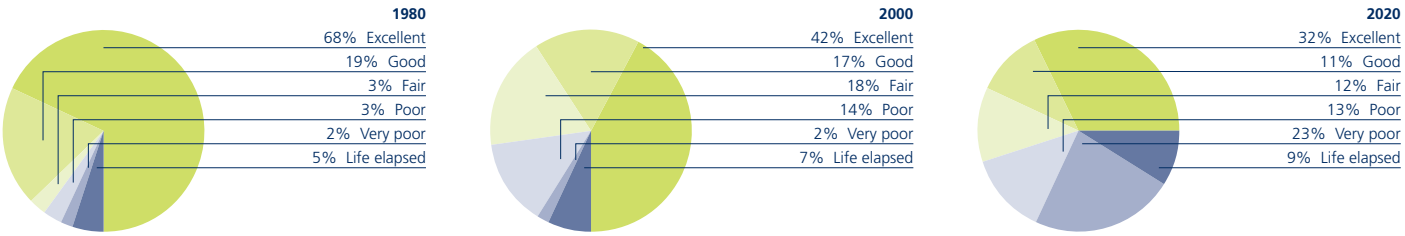
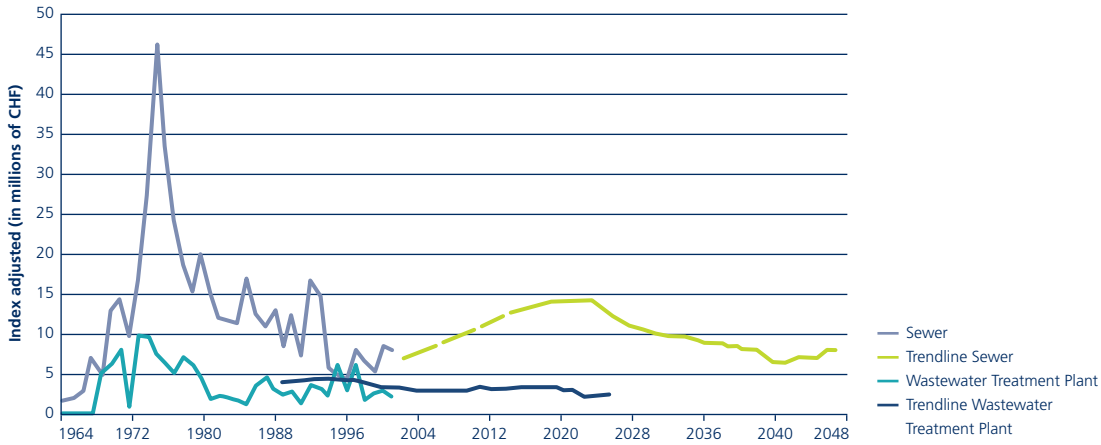


Figure 10: Yearly maintenance capital expenditure in Canton of Schwyz, Switzerland
The sewer network in the Canton of Schwyz is a good example of the expected capital expenditure (capex) required for maintenance of the sewer infrastructure in Switzerland. The green curve reflects the projected capital investments needed to maintain the existing network.
Source: Environmental Protection Agency, Canton of Schwyz.



- London loses 30 percent of its fresh water through leaks in its antiquated pipe system.[20] Under pressure from the industry regulator, the network operator Thames Water is replacing more than 1500 km of the aging supply network within five years. A planned GBP 200 million desalination plant will eventually supply 15 percent of the freshwater currently lost through leaking pipes.[21]
- Water use is also unefficient in France and Spain: Around 30 percent of water is lost before it reaches the end consumer.[22]
- There is also a continuous effort to renovate the sewer system in Switzerland, most of which was constructed in the second half of the 20th century and needs to be renewed over the next few decades.[23] About 23 percent of the sewer network currently has significant or serious defects and needs to be renovated in the mid term.[24] The situation is even more critical in the residential property sector, where up to 85 percent of the pipe-work is substandard.[25]

2.3 HIGHER WATER QUALITY STANDARDS

In many countries, the population is suffering not only from a shortage of water, but also from the poor quality of the water that is available. More than 1 billion people worldwide have no access to safe drinking water.

This situation is mainly caused by three factors:

- In developing countries, many residents of urban areas are not connected to a proper sewer system. The wastewater from these households is released into the environment without any form of treatment, polluting groundwater and surface waters in the process. Solid waste is also frequently dumped into watercourses.
- In many countries, industrial effluent is inadequately treated. This is a critical problem in China, for example.
- The fact that farmers have managed to increase their food production so significantly in recent decades is mainly due to the increased use of crop

Even in extremely arid countries, very little care is taken in using this precious resource.

[20] Dow Jones Newswires: SAM sees steady growth in world water sector, 2010.

[21] Telegraph.co.uk (24.07.2007).

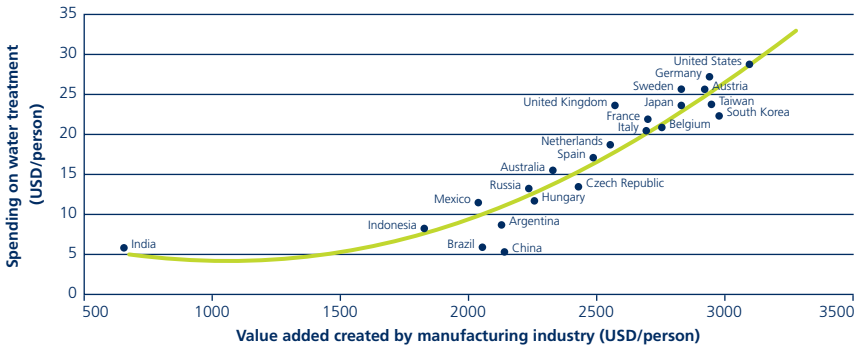
[22] European Environment Agency: http://www.eea.europa.eu/themes/climate/ (5.10.2007).

[23] Lehmann, M.: Volkswirtschaftliche Bedeutung der Siedlungswasserwirtschaft. Gas Wasser Abwasser 6/94, 1994.

[24] Herlyn, A.: Status quo der Schweizer Abwasserentsorgung. Gas Wasser Abwasser 3, 171-176, 2007.

[25] Gränicher, H. U.: Die neue VSA-Richtlinie – Baulicher Unterhalt von Abwasseranlagen. Kanalisationsforum, Bern, 2006.

Figure 11: Water treatment and the creation of industrial value-added
The higher the value created by manufacturing industry, the higher the level of spending on water treatment tends to be.
Source: Nalco; Freedonia, 2006.



protection agents and fertilizers. In many regions, these substances are now contaminating the water and polluting the groundwater.

The range of potential pollutants is enormous: Organic matter decomposing in the water removes the oxygen that is vital for sustaining life; feces contaminate the water with bacteria and micro-organisms that spread disease; the runoff from overfertilized fields floods rivers and lakes with harmful nutrients; overwatering and excessive groundwater extraction increases soil salinity; acid rain changes the pH value; heavy metals and toxic compounds from industrial processes contaminate drinking water; and inappropriate cultivation methods release large quantities of fine particulates into the water, which also causes the water quality to deteriorate.

The lack of adequate sanitation facilities in countries with poor infrastructure is one of the major causes of widespread gastrointestinal disorders. This can have fatal consequences for children, in particular. The number of deaths caused every year by contaminated water is estimated at up to 5 million worldwide. The installation of a comprehensive sanitation system as typically found in industrialized nations is not feasible within a reasonable timeframe, mainly because cities in these countries are growing so rapidly. Because of this, simpler solutions to the sanitation problem in these countries are being sought.

In China, more than 75 percent of rivers flowing through urban areas are considered unsuitable for drinking or fishing.

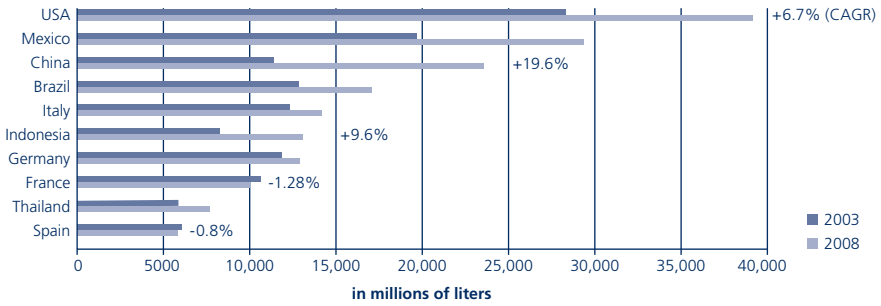
One point worth raising in this context is that a correlation has been found to exist between water treatment and economic prosperity. A comparison of different countries shows that those with a high level of value-added spend more money per capita on water treatment than less prosperous countries.

It is interesting to note from this comparison that China spends comparatively little on wastewater treatment.[26] The growing number of reports about severely polluted watercourses in the world's most populous country is less surprising. Many rivers in China are so badly polluted that not even industry can use the water. In China, more than 75 percent of rivers flowing through urban areas are considered unsuitable for drinking or fishing. About 700 million people drink water that is contaminated with animal or human waste and water pollution causes about 60,000 premature deaths every year.[27]

[26] Nalco Freedonia, 2006.

[27] Responsible Research: Water in China, 2010.

Figure 12: Annual consumption of bottled water
Source: CLSA Asia-Pacific Markets: Thirsty Asia 2, January 2010.



New pollutants in the water

In industrialized countries, decent water quality is more or less guaranteed nowadays thanks to the provision of advanced water and wastewater treatment. But these countries are increasingly facing new challenges. Investigations in Switzerland have shown that despite the construction of new sewage treatment plants, hazardous chemicals are still entering the watercourses. Especially in times of heavy rainfall, acute concentrations of toxic nitrogen compounds, such as nitrites and ammonium, are being detected at sewer overflows and large quantities of pesticides and nitrate find their way into the groundwater when they are used in farming.[28]

Another problem is the constant stream of new substances and compounds entering the water cycle that wastewater treatment systems are unable to remove entirely.[29] The trickiest are endocrine-active substances, which can have a negative impact on any living organisms in the water.[30] Another problematic aspect as far as wastewater treatment is concerned is that many of these substances are excreted in human urine. The water used for flushing heavily dilutes these substances however, thereby making it more difficult to remove them, even with the help of the latest technologies in sewage treatment systems.[31]

Greater health awareness

For increasing numbers of people in developed countries, water is not only a basic commodity but also a lifestyle product. In Germany, for example, today's consumer can choose from about 500 different domestic water brands, all of them different in terms of taste and origin. And these are complemented by many other types of mineral water imported from abroad.[32]

In many countries, people rely on drinking bottled water due to the insufficient quality of local tap water. Growth in this industry has been very strong for many years now, averaging 8 percent by volume per annum for the last 10 years, even though the growth rate is now slowing or even negative in certain countries such as the U.S. On the other hand, demand for bottled water is growing faster in developing countries, driven by contaminated and unsafe drinking water. During the period 2003 to 2008, demand for bottled water in China grew at a CAGR of 15.6 percent, while consumption in the U.S. grew by 6.7 percent.[33]

[28] EAWAG, Dübendorf; BUWAL, Bern: Fischnetz – Dem Fischrückgang auf der Spur. Schlussbericht des Projekts Netzwerk Fischrückgang Schweiz, 2004.

[29] Wild, D.; Reinhard, M.: Biodegradation residual of 4-octylphenoxyacetic acid in laboratory columns under groundwater recharge conditions, Environmental Science and Technology, 33, No. 24, 4422-4426, 1999.

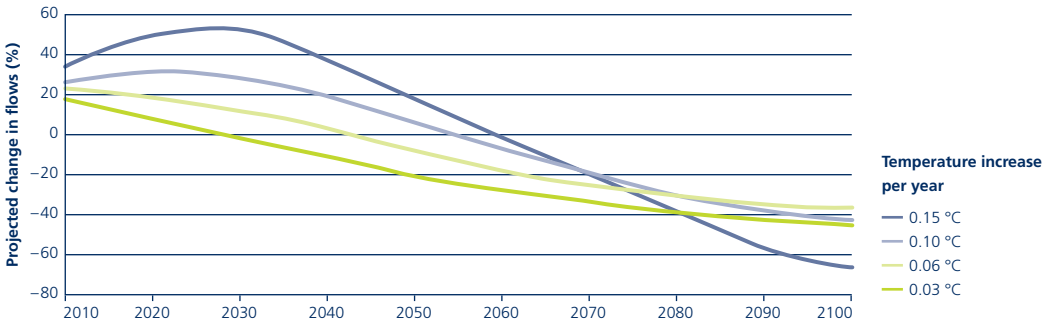
[30] Buffle, M.-O.: Treatment of Endocrine Disrupting Compounds by mean of Advanced Oxidation, EDC workshop, Montgomery Watson, London, UK, 2007.

[31] European Environment Agency: http://www.eea.europa.eu/themes/climate/ (5.10.2007).

[32] Informationszentrale Deutsches Mineralwasser: http://www.mineralwasser.com/ (5.10.2007).

[33] CLSA Asia-Pacific Markets: Thirsty Asia 2, 2010.

Figure 13: Runoff volume from the Indus river under changing climate conditions
The runoff pattern could vary widely, depending on how quickly the average global temperature changes in the coming years. Even if drastic measures are taken to combat climate change, the runoff volume will still drop significantly over the course of this century.
Source: UNDP: Human Development Report 2006.



In many regions of the world, climate change will have a significant impact on global water resources in the coming decades.

2.4 CLIMATE CHANGE

In many regions of the world, climate change will have a significant impact on water resources in the coming decades. In its latest report, the Inter-governmental Panel on Climate Change (IPCC)[34] anticipates the following trends:

- In the high latitudes and in some tropical regions, the average annual runoff will increase between 10 and 40 percent by the middle of this century.
- It is likely that even more areas will be affected by drought and water shortages will be more common.
- An overall increase in the frequency of heavy downpours is predicted. This also makes it more likely that human settlements will experience severe damage.
- The volumes of water stored in glaciers and the snow pack will decline over the course of the next century. This means that after a phase of increased discharge there will be less water available in regions supplied by meltwater running off from major mountain chains. This is an ominous development, because more than one-sixth of the world's population currently lives in these regions.

Impact will vary from one region to the next

In addition to these general statements, the IPCC also provides forecasts on the effects of global warming on specific regions:

- Within Europe, the Mediterranean countries will be most heavily affected by climate change. The IPCC predicts that Southern Europe will generally have to cope with far more difficult conditions, including high temperatures, extreme drought, poor water availability and subsequently limited potential for exploiting water as an energy source.

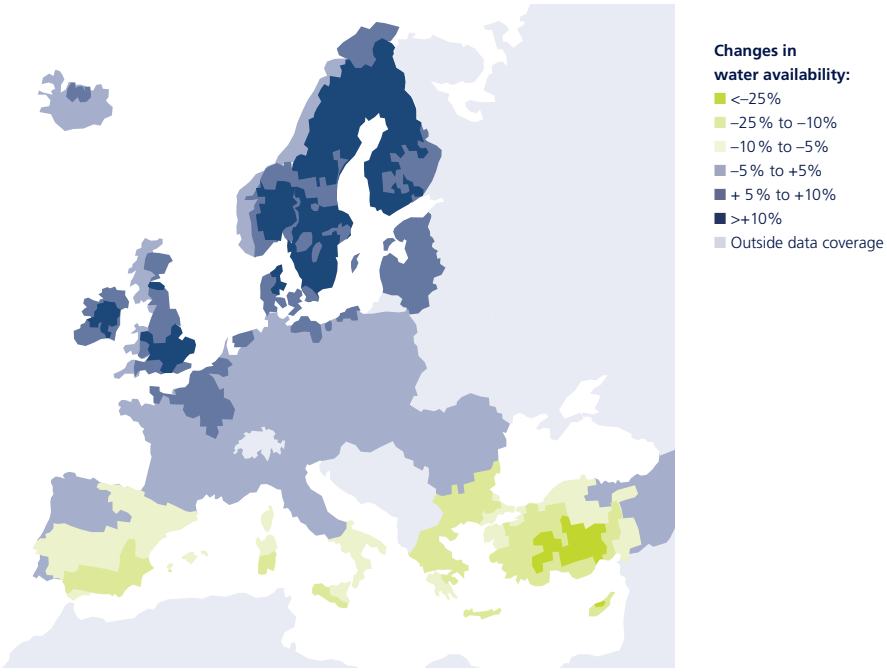
[34] IPCC, WMO/UNEP: Climate Change 2007: Summary for Policymakers, 2007.

Severe glacial erosion illustrated by the photos of the Grinnell glacier in the Glacier National Park in Montana (U.S.).
Source: Northern Rocky Mountain Science Center.

Image 1: 1938
Image 2: 1981
Image 3: 1998
Image 4: 2006

- In Central and Eastern Europe, IPCC predicts less rainfall in the summer. This could spell trouble, since some parts of this region already experience relatively low rainfall throughout the summer.
- In Central, Southern, Eastern and Southeast Asia the volume of freshwater available in the large river basins is predicted to fall.
- The water supply problems in Southern and Eastern Australia, as well as in New Zealand, are likely to deteriorate up to 2030 due to evaporation and less rainfall.
- In North America, it will mainly be the west of the country that will be affected by the impact of climate change on the hydrological regime. Rising temperatures in the western mountains will make the snow pack shrink, increase flooding in winter and result in lower runoff volumes in summer. This is likely to intensify competition for the over-exploited water resources in that region.
- Even countries that do not directly experience water shortages as a result of changing weather conditions will feel the ripple effects of climate change. In Switzerland, low-lying areas can expect to experience more frequent and in some cases more devastating flooding in winter and spring as a result of climate change.[35] At the same time, unusually dry spells in the summer are likely to increase significantly.[36]

Figure 14: Changes in water availability in Europe
The map shows which regions will have more or less water available in 2020 than at present as a result of climate change.
Source: The European Environment – State and Outlook 2005.



[35] OcCC / ProClim: Klimaänderung und die Schweiz 2050 – Erwartete Auswirkungen auf Umwelt, Gesellschaft und Wirtschaft, 2007.

[36] Bundesamt für Umwelt (BAFU): Klimaänderung in der Schweiz – Indikatoren zu Ursachen, Auswirkungen, Massnahmen, 2007.

3 INVESTMENT OPPORTUNITIES

3 Investment opportunities

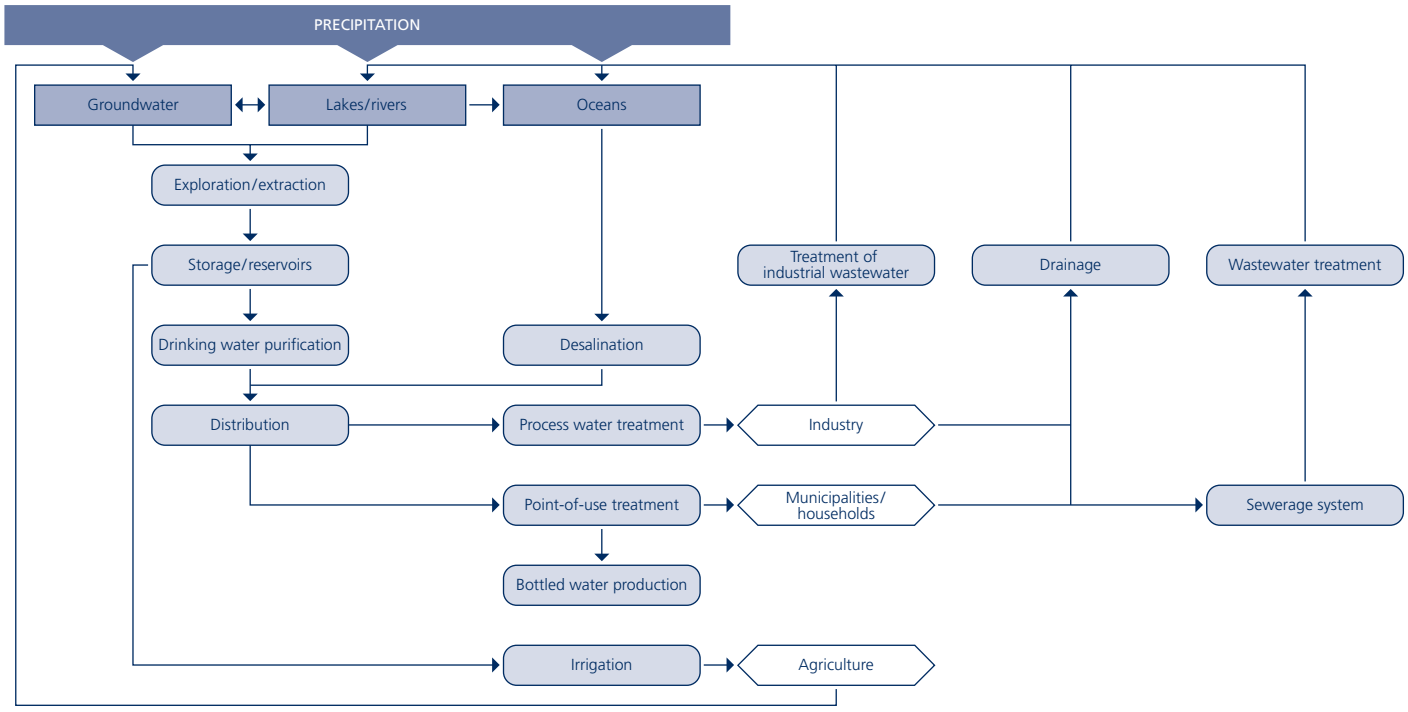
The many different challenges surrounding the use of water resources present a number of attractive opportunities for investors. Based on the global trends that will shape the water sector in the coming years, we can identify four investment clusters that offer great potential:

1. Distribution and management
2. Advanced water treatment
3. Demand-side efficiency
4. Water and food

A successful investment strategy is based on three key principles: It complies with the basic principles of sustainability, it adheres to a set of general investment principles, and it takes the entire value chain into consideration. In the case of domestic water supply, for example, this includes a whole series of elements: forecasting natural disasters and providing protection against them; exploring, extracting and transporting water reserves; treating and disinfecting drinking water; distributing water to end consumers; measuring the volume of water sold; domestic water use; drainage into the sewer system; treating the wastewater in sewage plants; reusing the greywater for other purposes or channeling it back into natural watercourses.

If we look at the entire value chain, the spectrum of investment opportunities is actually very broad and encompasses companies that at first sight appear to have little direct connection with the theme of water, but are closely linked indirectly to the sector: Food production is one example.

Figure 15: The water value chain
Water value chain (simplified). Attractive investment opportunities exist along the entire chain.
Source: SAM.



The global water market and the financial crisis

The latest estimates put the size of the global water market at over USD 480 billion in 2010, including USD 175 billion for municipal and industrial water and wastewater capital expenditure.[37] Services, engineering, operation, maintenance and chemicals make up the rest of the market.

Over the last two years, the financial crisis has caused a dramatic economic downturn, with weak residential and commercial construction markets, delays in large infrastructure projects and a decline in industrial production. Against this backdrop, it became more challenging for water companies, utilities and municipalities to find funding for investment projects. Public finance for infrastructure maintenance and upgrades was temporarily impaired due to, for example, the difficulty in issuing municipal bonds. Tightened liquidity and higher costs of borrowing forced companies to postpone necessary asset improvements.

As consumers faced the fear of unemployment it was politically difficult to raise water tariffs in line with the need for infrastructure investments. But it was also recognized that the vicious circle of low tariffs leading to poor profitability, poor services and ultimately low consumer willingness to pay, should be avoided.

Consequently the global recession has caused a decrease in water capital expenditure growth, but continuation of growth at the pre-crisis rate is expected for the years after 2010. Ongoing water scarcity and increasing pressure on limited global water resources remain the secular drivers of growth in the water sector. Including the impact of the financial crisis, global water capital expenditure is therefore still expected to grow at a CAGR of 6.2 percent in the period 2010 to 2016.

Furthermore, the financial crisis also triggered a number of positive changes. Some countries have incorporated water infrastructure spending into stimulus packages as a direct response to the economic crisis. In the context of the American Recovery and Reinvestment Act of 2009, over USD 14 billion were dedicated to water, sewerage and federal water projects. Many of the projects to be funded were already in the pipeline for execution over the next several years and are now being brought forward.

The Chinese government looks set to double the amount it is committing to environmental protection in the 12th Five-Year Plan for 2011 to 2015. USD 450 billion is estimated to be earmarked for environmental protection and pollution control, including a significant proportion for water and wastewater treatment. This amount represents almost 1.5 percent of China's projected 5-year GDP figure.

In water-scarce California, legislators passed a comprehensive package to overhaul the state's water system. The plan calls for a comprehensive ecosystem restoration in the Sacramento-San Joaquin River Delta, the construction of new dams, water storage projects, infrastructure improvements, aggressive water conservation goals and the monitoring of groundwater use, as well as paves the way for a new canal that would move water from the north to the south of the state.

Whereas certain segments of the water market can look forward to growth rates of 5 to 10 percent over the next 10 years, major differences will prevail when it comes to regions and sectors.

Regional differences

Regional differences are significant. Based on economic growth and the need to catch up with basic infrastructure, water sector investments in emerging markets are expected to grow faster than in developed markets.

Growth is likely to be sluggish in a number of European markets and Sub-Saharan Africa. Other

[37] GWI: Global Water Market 2011, 2010.

countries will however enjoy above-average growth rates, especially emerging Asia and the Middle East and North Africa (MENA). The U.S. market is expected to grow in the coming years, driven by increased levels of investment to expand and upgrade aging water infrastructure as well as to meet the growing water demand in water-scarce areas where the population continues to grow, particularly in Southern California. This market continues to be heavily influenced by public budgets and water-related policies.

Economic performance in the Middle East is closely linked to the provision of additional water through desalination, leading to strong growth rates for related technologies and services.

Areas of more acute water stress have seen greater investment. China and Australia are two such examples. In Australia, problems are concentrated in the south. According to the Murray-Darling Basin Authority (MDBA), water flow into the Murray and its main tributary, the Darling, is now at a 117-year low. The MDBA has warned that there may not be sufficient water flow to meet the "basic human needs" of the 1 million population of Adelaide from as early as next year as Adelaide has had to rely on the Murray-Darling basin for 85 percent of its water supply. Total annual water and sewage capital expenditures by the Australian water utilities have increased by 220 percent since 2002.[38] Driven by a government-led program, total water and sewerage capital expenditure is projected to increase by another 60 percent over the next 9 years.

Figure 16: Global forecast for water, wastewater and desalination expenditure
Source: GWI: Global Water Market 2011, 2010.

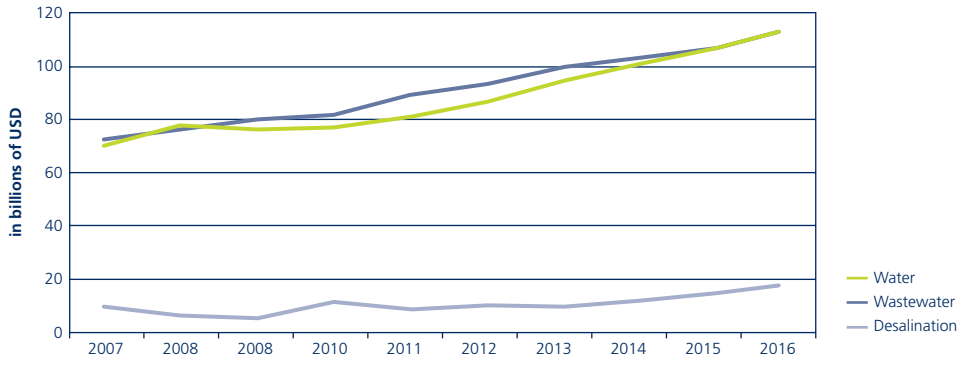
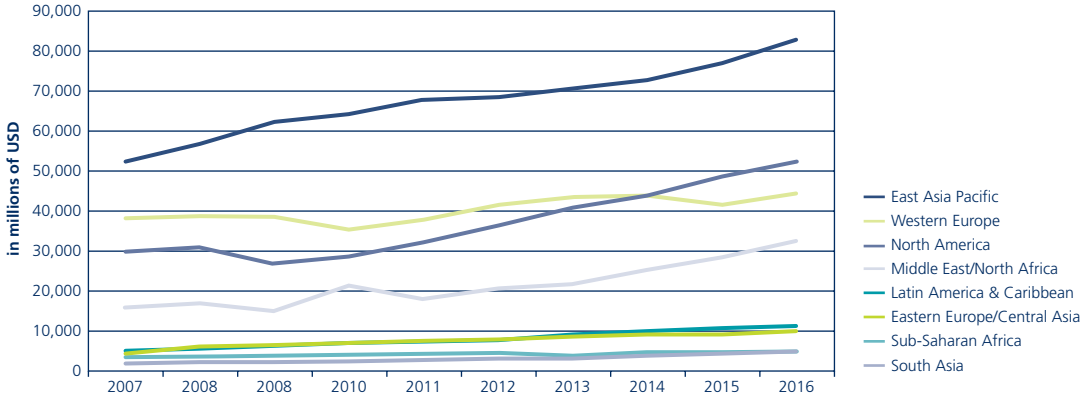


Figure 17: Regional forecast for water and wastewater capital expenditure
Source: GWI: Global Water Market 2011, 2010.



[38] Water Services Association of Australia: WSAA Report Card 2008-2009, 2009.

Consolidation of the water industry

The water industry is heavily fragmented at the moment. In Switzerland, for example, there are still about 3000 water utilities and 1000 organizations operating sewage treatment plants, while in Germany there are 4833 water utilities and 6900 wastewater companies. Globally there are an estimated 250,000 plants in service, all of them operating under very different economic and legal conditions.[39] The supplier industry is also heavily fragmented. This is because no individual technology dominates the market and local providers often have to be catered for. Nevertheless, a number of global players have established themselves by building up their water business in the last 10 years, especially through the acquisition of smaller, specialized companies.

Bigger companies are trying to generate additional growth by developing a global distribution network. This will inevitably speed up the consolidation of the market. This trend will be fueled by the fact that local authorities are increasingly opting for integrated solutions along the lines of public-private partnership (PPP) models. Looking at the different options available for establishing water purification and wastewater treatment plants, the picture that emerges is quite varied: Market growth rates are lowest for those projects where the local authorities commission specialist firms to handle only the planning aspects. By contrast, the Build-Operate-Transfer (BOT) segment of the market is enjoying more than double the rate of annual growth, at 13.6 percent.[39] With the BOT model, local authorities commission all-inclusive solutions, *i.e.* a single contractor handles the financing, planning, construction and operation of the plant. Companies able to offer the entire range of services therefore enjoy a competitive advantage.

New openings for private providers

In most countries, public authorities or state-owned organizations are responsible for the drinking water supply and wastewater treatment. Only in a few countries have these sensitive areas been privatized or organized as PPPs. In recent years, however, the number of people whose drinking water and wastewater services are provided by private companies has increased significantly. In Europe, 44 percent of the population is served by the private sector, about 21 percent in North America and 12 percent in Southeast Asia.[40]

Globally active private operators currently account for roughly 19 percent of all investments in facilities for drinking water supply and wastewater treatment. The remaining 81 percent are invested by public authorities or state-owned organizations. The same percentage applies when it comes to running costs.

The proportion of private companies is expected to rise to almost 30 percent by 2016.[39]

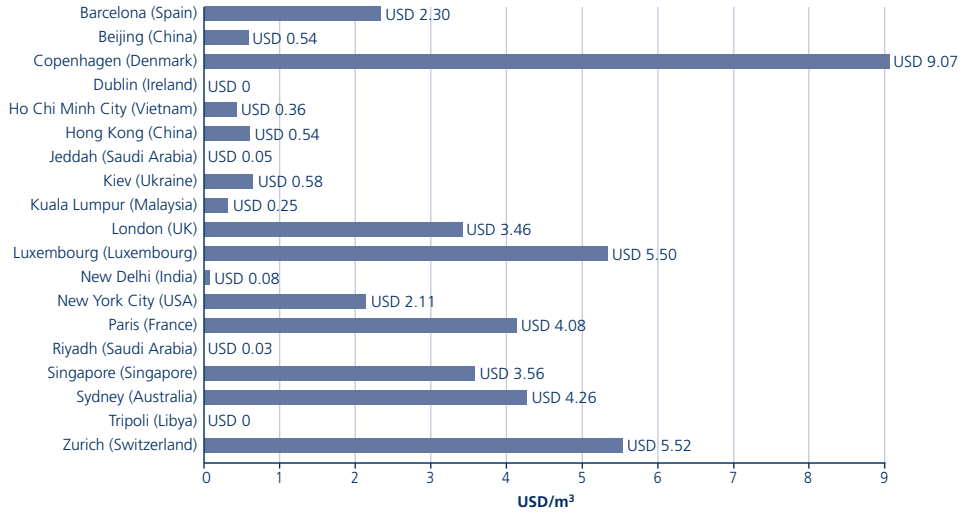
In many countries, however, there is an underlying skepticism towards private water utilities for a wide variety of reasons. Both positive and negative examples can be produced to support or challenge their case. International organizations, such as the World Bank's Public-Private Infrastructure Advisory Facility (PPIAF), offer comprehensive support in the preparation and definition of agreements with private operators, in order to avoid subsequent conflicts.

Opportunities do exist for companies to establish themselves as private operators, particularly in the Middle East and East Asia. The strongest growth in private investment is therefore expected in these regions.

[39] GWI: Global Water Market 2008, 2007.

[40] Credit Suisse Research: Water, the pressure is rising, 2009.

Figure 18: Global water and wastewater tariffs (combined)
Source: GWI: Global Water Market 2011, 2010.



Water tariffs increasing

Whereas most utilities encounter problems in raising cost covering water tariffs, the price of water has in-creased significantly in many places around the globe in recent years. In the U.S. and UK, water tariffs have outstripped headline inflation by 18 percent and 27 percent respectively over the past five years.[41]

There is considerable disparity in water prices between countries. The price of a cubic meter of water in France, which is relatively water-rich, is about 50 percent higher than the price of a cubic meter of water in Spain, which is considered to be water-poor. Also, countries like the UK, Denmark and Germany set tariffs not only covering operating costs, but also covering the capital financing costs to a large degree. On the other hand, in countries like Libya, Ireland and Turkmenistan, which barely charge for water services at all, the taxpayers bear the entire financing burden. In China and India, water is very cheap as a percentage of disposable income, but this fosters over-extraction of water resources, a situation that will prove to be unsustainable in the long term.

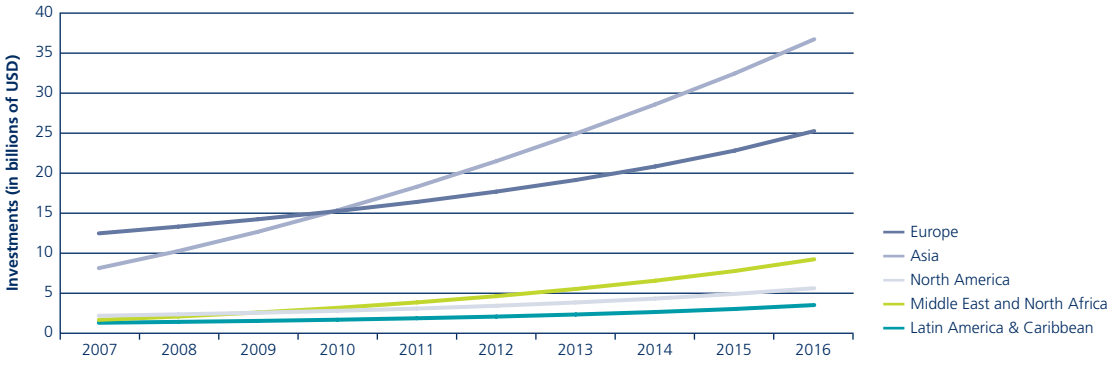
In the case of China, in 2009 the integrated water price of 36 large and medium-sized cities went up 5.5 percent year on year to CNY 2.88/m³. Larger increases can be expected in the years ahead, given that many hike requests have been lodged with the local pricing agency but have yet to be implemented.[42] The latest tariff announcement highlights the government's strong commitment to raise tariffs, and an important factor for the future development of the Chinese water market.

The need to upgrade or build installations is intensifying and at the same time the pressure for higher water standards has also intensified. Significant capital requirements, in conjunction with fiscal constraints limiting central government expenditure, imply higher prices. Higher tariffs may also reduce inefficiencies in the use of water. The Australian Water Association predicts that prices will double in Australia over the next 5 years to meet the rising costs of production and to fund investment. This follows a 38 percent increase in average water prices over the past 2 years. A number of other

[41] Credit Suisse Research: Water, the pressure is rising, 2009.

[42] Nomura Research: Water & Environment Asia, 2010.

Figure 19: Growth of private investments
Expected annual investments made by private water and wastewater suppliers in different market regions.
Source: GWI: Global Water Market 2008, 2007.



utilities, like Phnom Penh Water Supply Authority, Manila Water, and Senegalaise Des Eaux have also raised their tariffs in recent years.[43]

Where poverty and affordability is an issue, water tariffs can take the form of a tiered pricing system. This enables water provision at very low prices to cover 'basic household needs', typically 30-50 liters per person per day, but acts as a deterrent to over-use. Tiered pricing schemes have been successfully implemented in Israel, Australia, Hong Kong, Japan, Korea and parts of the U.S.

3.1 DISTRIBUTION AND MANAGEMENT

Exploration

To meet soaring demand for drinking water, the ability to locate and exploit new water reserves is becoming far more important. In some cases this means tapping into aquifers under very challenging geological conditions. A number of modern drilling technologies capable of reaching very high depths are used for this task.

The highest quality standards must be adhered to, particularly when tapping into new sources of water. To ensure that a new source is capable of delivering water of sufficiently high quality over the long term, boreholes are now equipped with devices

Table 4: Distribution and management
Overview of selected segments of the global market.
Source: GWI: Global Water Market 2011, 2010.

	Market volume 2010 (USD bn)	Expected annual growth (2010-2016 CAGR)
Pumps	20.7	6%
Valves	5.9	5%
Pipes	36.2	6%
Pipes rehabilitation services	28.6	5%
Engineering, planning and construction	49.7	6%
Water operating expenditures	134.9	2%
Wastewater operating expenditures	87.3	3%

[43] GWI: Global Water Market 2011, 2010.

capable of providing operators with information about the hydrological situation beneath the ground. Specialist companies are now able to use state-of-the-art monitoring techniques to inspect existing water sources and related infrastructure, and carry out the required maintenance work where necessary.

Expansion of distribution networks per year

Worldwide, current annual capital expenditure by utilities on water infrastructure is estimated at USD 90 billion, spending on wastewater infrastructure is estimated at USD 82 billion. Capital spending per annum on water and wastewater infrastructure by 2016 is projected to grow at a CAGR of 6.5 percent and 5.6 percent, respectively.[44] In the case of both drinking water and wastewater, more than half of the investments will be directed to new water and wastewater networks and network rehabilitations. Current capital investment of about USD 85 billion is directed to new water and wastewater networks, and network rehabilitations. This amount is expected to reach more than USD 120 billion over the next 6 years. In addition, current operating expenditures amount to USD 135 billion and USD 87 billion for water and wastewater, respectively. Providers of services and equipment such as pipes, pumps, valves, building materials as well as engineering and construction firms specializing in the water business all stand to benefit from this trend.

The bulk of this growth is attributable to the burgeoning global population. Since the population is growing fastest in developing countries, economical as well as efficient technologies are needed to cater for these countries' requirements. Decentralized water supply and wastewater treatment systems also play an important role here, since the provision of new infrastructure cannot keep pace with rapid urbanization.

Nowadays a number of different techniques are used for pipework construction and maintenance: These include laying pipes by excavation or using trenchless technology, cement mortar linings, slip-linings and long pipe relining. Particularly in built-up areas, where most of the systems in need of renovation are located, alternative pipelaying technologies are in greater demand in order to minimize the disruption on the surface. New approaches are also being developed for maintaining pipework. In particular, these include monitoring and early detection of damage using remote-controlled cameras.

[44] GWI: Global Water Market 2011, 2010.

Management

In a number of regions there has recently been a move towards an integrated approach to the management of limited water resources. The European Union has adopted common guidelines for this, in the form of the EU Water Framework Directive. Intelligent approaches that promote sustainable management of water resources are required. Individual companies have specialized in the management of entire river basin areas and ecosystems. To this end, they use sophisticated remote control and geoinformation systems, besides more traditional assessment methods. Management services of this type will become increasingly important, as climate change will have a dramatic impact on the water supply in many regions. Because of this, it is likely that the distribution of water in various river basins will need to be reviewed, as part of a proactive risk management policy.

3.2 ADVANCED WATER TREATMENT

Wastewater treatment

Demand for wastewater treatment is set to rise sharply in the coming years. This is particularly true for Asia: In India and China, untreated industrial and communal effluents are posing a serious threat to the population's health. In these two countries especially, enormous investments are required to bring wastewater treatment up to a standard that is commensurate with these countries' economic standing.

Currently, global utilities invest more than USD 165 billion in wastewater capital expenditure and operating expenditure each year and this figure is expected to reach USD 220 billion by 2016. The challenge is not simply to channel the water back into the waterways once it has been treated, but to process it so that it can be reused for other applications, for example landscape irrigation such as watering golf courses, groundwater recharge or

Table 5: Advanced water treatment
Overview of selected segments of the global market.
Source: GWI: Global Water Market 2011, 2010.

	Market volume 2010 (USD bn)	Expected annual growth (2010-2016 CAGR)
Primary intakes/screens	2.9	7%
Standard process equipments: aeration/flocculation/clarifiers/sedimentation/mixers	10.9	5%
Ultrafiltration/microfiltration membranes	0.7	18%
Reverse osmosis/nanofiltration	0.6	18%
Membrane bioreactor	0.1	17%
Ion exchange/electrodeionisation	0.3	15%
Disinfection	3.0	6%
Zero liquid discharge	0.4	26%
Sludge management	7.1	9%
Media filtration	3.7	6%
Monitoring control/analytics/chemical feed	2.3	7%
Other specialist systems	2.6	2%
Industrial water treatment services	2.9	5%
Desalination plants	11.0	9%

even reuse for potable water supply and other recreational uses. There has been an increasing trend for water reuse projects such as the Singapore NEWater, Australia's Western Corridor and Orange County New Blue Water program in California to deliver high-quality treated water that can be used to augment potable water supply, through blending in reservoirs, storing in aquifers or selling directly to industrial users.

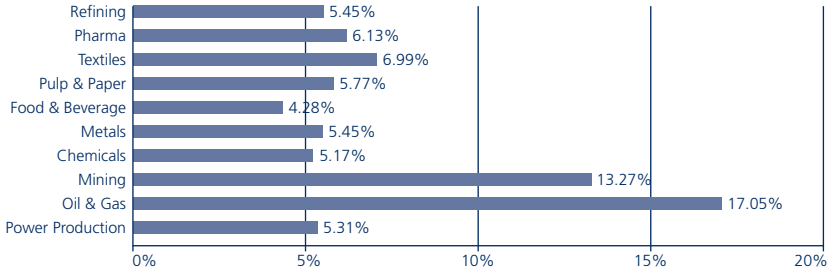
Worldwide, the total volume of wastewater produced per day is estimated to be about 684 million m^3 and the total capacity of tertiary and advanced reused water produced per day is about 28 million m^3. Capital expenditure for water reuse is projected to rise from USD 4.9 billion in 2010 to USD 8.4 billion in 2016.[45]

Lately the industrial wastewater treatment market has received much attention as environmental regulation on effluent discharge are getting stricter and tougher. The potential for water reuse and industrial wastewater treatment in the industrial markets is becoming an attractive source of growth for water technology companies. For example, the Oil & Gas sector requires increasing amounts of water and wastewater treatment technology. The total expenditure for the Oil and Gas industry in water and wastewater treatment equipments including chemicals is projected to grow at a CAGR of about 17 percent over the next 6 years, the fastest growth rate among all other industries. Current investment in water and wastewater equipment for industrial markets is estimated at USD 14 billion in 2010 and is projected to reach USD 23 billion in 2016, representing a CAGR of 7.5 percent.[45]

Among the industrial wastewater treatment technologies, the reverse osmosis market is expected to be one of the fast-growing areas. The industrial reverse osmosis membrane market is expected to grow from USD 238.5 million in 2010 to USD 647.9 million in 2016, representing a CAGR of 18 percent.[45] The ultra-filtration/microfiltration market will also experience a high growth rate of CAGR of 17 percent, while standard process equipment such as aerators, and sedimentation systems is likely to achieve only a CAGR of 1.6 percent. As the regulatory barriers to discharging effluents for many industries have been raised, the market for zero liquid discharge systems, including brine concentrators, crystallizers and evaporators, is expected to enjoy an above-average growth rate in the coming years.

At the same time, new challenges are constantly arising. For example, the contamination of wastewater with endocrine-active substances presents a serious problem that urgently needs to be solved, as conventional sewage treatment plants are generally not up to the task. The entire chain – from the polluter through to release into the waterways

Figure 20: Industrial end-user: Water and wastewater equipment & chemical market (CAGR from 2010-2016)
Sources: GWI: Global Water Market 2011, 2010; SAM.



[45] GWI: Global Water Market 2011, 2010.

– needs to be rethought. If attempts to remove the problematic substances at source are unsuccessful, more sophisticated wastewater treatment techniques, such as ozonation or advanced oxidation might be necessary.[46]

Drinking water disinfection

Providing clean drinking water is one of the main missions of the water industry. The task here is to provide water not simply in sufficient quantity, but also of sufficient purity. There are a number of ways to treating water to make it fit to drink, including disinfection with ozone, chlorine or chlorine dioxide, ultraviolet radiation or purification using membrane filters. Ozone and UV treatment both have significant growth potential. The market for membrane technology is particularly attractive, with sales in the drinking water segment expected to expand by a factor of 3 within 6 years.

Desalination

Over the past 5 years, total global desalination capacity has grown by 55 percent. By 2010 the installed capacity should reach 66 million m^3 per day and is forecasted to reach 120 million m^3 per day by 2016. This implies a CAGR of 10.5 percent. The capital expenditure on desalination plants will rise from USD 11 billion in 2010 to USD 18 billion in 2016.

Interestingly, in 2009, approximately USD 4 billion was invested in membrane systems desalination plants compared to USD 1 billion in thermal desalination plants. These figures are expected to reach USD 13 billion and USD 5 billion respectively by 2016.

Growth in desalination using membrane technology is expected to outpace thermal desalination. The MENA region is set to be the key region, accounting for more than 60 percent of the world's desalination plants by 2015.[47]

Figure 21: Desalination versus reuse additional capacity
Source: GWI: Global Water Market 2011, 2010.

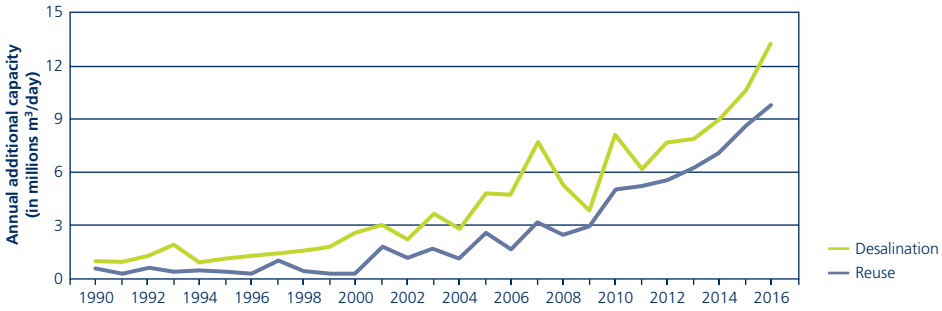
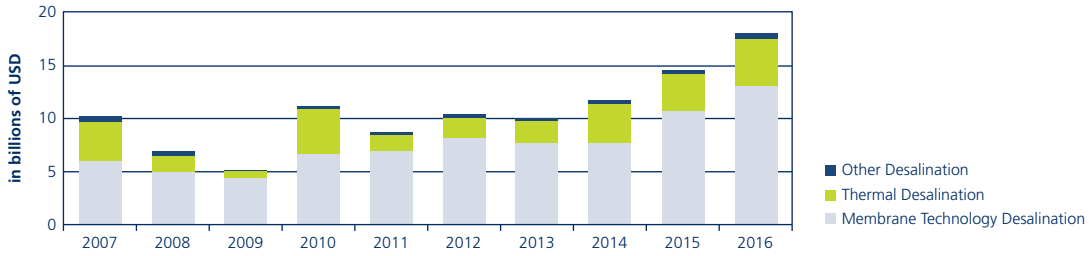


Figure 22: Membrane systems desalination versus thermal desalination
Source: GWI: Global Water Market 2011, 2010.



[46] Buffle M.-O., et al.: The Use of UV and Hydrogen Peroxide in Wastewater Reuse to Accomplish Multiple Treatment Objectives. IWA Wastewater Reclamation and Reuse Conference, Antwerp, Belgium, 2007.

[47] DBS Vickers Securities Research.

The cost of desalination has come down significantly. 40 years ago it cost as much as USD 10 to produce a m^3 of water. Newer desalination plants have brought costs down to well below USD 1 per m^3. For example, the Ashkelon plant in Israel reportedly desalinizes seawater for USD 0.53 per m^3 and Singapore is desalinizing for USD 0.49 per m^3. The MENA region is expected to invest USD 30 billion in desalination projects by 2015, having more than 60 percent of the world's desalination plants.[48]

3.3 DEMAND-SIDE EFFICIENCY

In many regions of the world, water has now become a precious good. The most efficient way to prevent overexploitation of available water resources is to invest in technologies that promote more efficient water usage. The aim here is to achieve the same level of service with less water, without compromising on convenience and performance.

Industry

Industrial water consumption has stabilized in industrialized nations over the past 20 years, per capita usage of industrial water fell from 927 liters in 1950 to 450 liters in 2000. This proves that efficient water use can be achieved together with solid economic growth. Despite massive efforts, industry is still the biggest consumer of water in Europe and North America. As water reserves continue to dwindle, additional initiatives will be necessary to reduce industrial water consumption further.

The situation is particularly critical in Asia: Industrial water consumption continues to rise in this region. In addition, in countries such as China many companies have discharged their industrial effluents into rivers without prior treatment. This has led to a massive deterioration in water quality in many cities.

Industrial water efficiencies can be achieved by water recycling as well as by cutting down water input into industrial processes through the use of chemicals/additives as well as metering to monitor and regulate the flow of water.

Today the market for industrial water treatment is worth roughly USD 27 billion and is forecast to grow to about USD 45 billion by 2016. This market also includes the manufacture of technical equipment, the provision of chemicals and additives for water treatment, and the development of integrated solutions.

Domestic consumption

Compared with the industrial sector, where water consumption has stabilized in Europe and North America at least, domestic water consumption continues to rise in most countries. Household water consumption varies enormously from one country to the next. This implies that large quantities of water could possibly be saved if appropriate technologies were installed.

Switzerland is a good example to illustrate how much potential there is: in the last 25 years, per

Table 6: Demand-side efficiency
Overview of selected segments of the global market.
Sources: GWI: Global Water Market 2011, 2010; SAM.

	Market volume 2010 (USD bn)	Expected annual growth (2010-2016 CAGR)
Water meters	2.1	7%
Domestic installations	14.9	15%
Chemicals/additives	19.5	4%

[48] DBS Vickers Securities Research.

Figure 23: Million hectares of irrigated agricultural area
Sources: FAO; ICID; SAM.

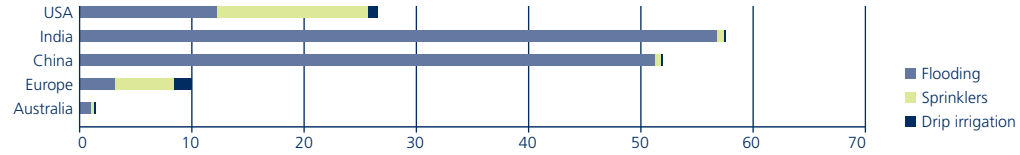
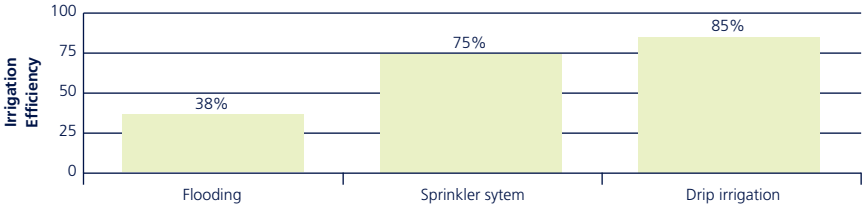


Figure 24: Irrigation efficiency
Source: Citigroup: Water Worries, 2009.

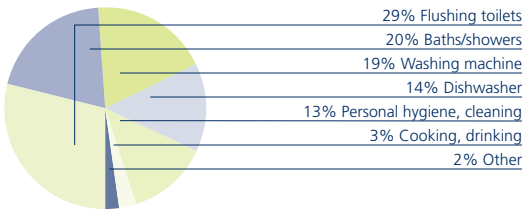


capita consumption has steadily declined. Today each Swiss resident consumes 160 liters of water a day on average to cover their personal requirements – roughly 20 liters less than 20 years ago. Almost 70 percent of the water consumed goes on flushing toilets, taking baths and showers and washing clothes – a similar pattern to the rest of Europe.

Household water-efficient devices like low-flush toilets, point-of-use devices that reduce tap flows and efficient plumbing systems offer significant water-saving potential.

Water efficiency can also be achieved through limiting water losses in the distribution network or through reducing non-revenue water (NRW). NRW includes water not billed due to leakage, illegal use and inadequate measurement. The NRW water stands in the range of 4 to 65 percent in Asian cities.[49] For improvements to be made, consumers need to be billed on the basis of water use, which is good news for companies that manufacture water meters. Modern water meters now have components to automatically record and/or transmit electronic data on water use.

Figure 25: Breakdown of water use in Swiss households
Source: European Environment Agency:
http://www.eea.europa.eu/themes/climate/ (5.10.2007).



3.4 WATER AND FOOD

Irrigation

Agriculture is by far the biggest consumer of water worldwide, accounting for about 70 percent of water use. Approximately 28 percent of cropland is now under irrigation, with half of this located in Asia. Many countries are starting to experience severe water shortages. There will be mounting pressure in these regions for fields to be irrigated more efficiently.

Nowadays most fields are irrigated using a system of ditches or sprinkler equipment. Although both of these methods are relatively economical, they are

[49] ADB: Asian Water Supplies, Reaching the Urban Poor, 2008.

Table 7: Water and food
Overview of selected segments of the global market.
Source: GWI: Global Water Market 2011, 2010; SAM.

	Market volume 2010 (USD bn)	Expected annual growth (2010-2016 CAGR)
Bottled water	59	8%
Organic food	51*	10-12%
Irrigation	10	10-12%

* Market volume 2008

also highly inefficient, because most of the water is wasted. Modern micro-irrigation systems could cut water consumption by as much as 30 to 70 percent. The positive side effects of this technology include the prevention of soil salination and the decreased use of pesticides.

While these new irrigation technologies are economically viable, the speed at which they actually establish themselves ultimately depends to a large extent on the available financing. It is usually the farmers themselves who have to make the investments in irrigation systems, and the amount available for investment depends largely on the farmer's income. One of the decisive factors is still the price that farmers have to pay for the water and the extent to which the authorities are prepared to clamp down on illegal water extraction. One interesting point worth noting in this context is that the current amount invested globally in irrigation systems amounts to about USD 10 billion, which is a surprisingly low figure given the importance of the agricultural sector for water consumption.

Sustainable agriculture

The global organic products market has seen sustained growth over the past decade, reaching an estimated size of USD 51 billion in 2008.[50]

In the U.S., sales of organic food grew from USD 3.5 billion in 1997 to an estimated USD 23 billion in 2008.[51] The most important markets for the import of organic products continue to be the EU, the U.S. and Japan.

In Asia, demand for organic food has been growing at 15 to 20 percent every year over the last decade – a remarkable growth rate in a region where agriculture competes intensively for land and other resources with the industrial and construction sectors. However, the market share of organic food products in Asia-Pacific remains small compared to leading organic food markets like the U.S.

Organic or sustainably produced foods are not only becoming increasingly popular with consumers, but also have a very positive impact on water resources. The use of more environmentally friendly fertilizers and crop protection agents also protects the groundwater and reduces topsoil runoff. Slow-release fertilizers act selectively and increase yields. This is key for sustainable agriculture practices, particularly in developing nations with burgeoning populations. Fortunately, specialist firms now exist, which stand to benefit from strong growth in this area.

India – also a country facing a major water crisis – has the world's largest rice cultivated area. With organic farming techniques, the system of rice intensification (SRI) has helped increase yields by over 30 percent while using 40 percent less water than conventional methods. This will not only massively reduce the use of water but also help ensure food security. Moreover, unlike more conventional farming techniques, such organic farming techniques do not emit methane (a powerful greenhouse gas).

[50] FiBL and IFOAM: The World of Organic Agriculture - Statistics and Emerging Trends 2010.

[51] The Organic Trade Association's 2009 Organic Industry Survey.

4 CASE STUDIES

4 Case studies

4.1 CHINA – THE DOWNSIDE OF MINING

Various trends combine to make China's water situation one of its greatest challenges as the country moves further into the 21st century. Urbanization, industrialization, historically weak environmental regulations, a per capita water consumption approaching that of the West and a population increasingly aware of the health impact of pollution are trends that have set the scene for what will be one of the largest governmental and private capital outlays in history, reaching USD 1.2 trillion over the next 20 years.

The village of Shangba[52] (Guangdong Province), while an extreme example, illustrates the challenge faced by regions undergoing rapid industrialization. The Dabaoshan mine, a major zinc mine that also produces up to 6000 tons of copper and 850,000 tons of iron ore annually, has over the years been the source of contamination of more than 500 hectares of agricultural land irrigated by the Hengshui river. Surface water and groundwater have been highly contaminated by heavy metals such as lead and cadmium. The water to irrigate crops exhibited concentrations of heavy metals well above international standards. This significant intake of heavy metals resulted in a very high incidence of cancer among the 3000 residents of Shangba.

While the situation may seem hopeless at first sight, a positive development has taken place. With the help of a major water technology provider and the determination of local government officials, a drinking water treatment plant applying coagulation and multi-media filter treatment processes was installed in October 2008. The system now reduces contaminant concentrations to international standards.

In recent years, China has significantly ramped up its efforts to increase wastewater treatment coverage. It had become clear that poor surface water quality (due to untreated municipal and industrial wastewater discharges) had had a negative impact on economic growth (annual GDP loss of 1.5 to 2.8 percent). This incentivized the central government to focus on increasing China's wastewater coverage, which translated into a USD 60 billion investment in wastewater infrastructure. The impact on the water sector has been significant, with many private companies taking advantage of this new market opportunity. Western visitors at Shanghai's Aquatech (an international water industry trade show) in June 2009 were impressed by the number of local water companies participating (> 300) and the variety of products displayed. In particular the large number of home treatment systems (point-of-use) was evidence that the Chinese population is becoming increasingly aware of water quality issues; this represents a key driver for future growth in the Chinese water sector.

WATER STATS

The Chinese water market is estimated at USD 40 billion per annum, growing at 11 percent per annum up to 2016. 40 percent of the market relates to municipal wastewater management, while 50 percent involves municipal drinking water management (not including point-of-use systems) and 10 percent industrial water treatment.

[52] Chen, A; Lin, C; Lu, W.; Wu, Y; Ma, Y; Li, J; Zhu, L.: Chemosphere, Well water contaminated by acidic mine water from the Dabaoshan Mine, South China: Chemistry and toxicity, 2007.

4.2 INDIA'S WATER AVAILABILITY COST CURVE

By 2030, India will face a large gap between current water supply and projected demand, amounting to 50 percent of demand or 754 billion m^3 of water. The agriculture sector is the biggest user of water, followed by the domestic sector and the industrial sector. The imbalance is driven by a burgeoning population and rapid economic growth, putting significant pressures on water resources. The over-extraction of groundwater in about two-thirds of the country has also caused depleting water tables and seawater intrusion in coastal regions. Furthermore, the demand and supply condition is made worse by the lack of water infrastructure in the country.

India's water demand

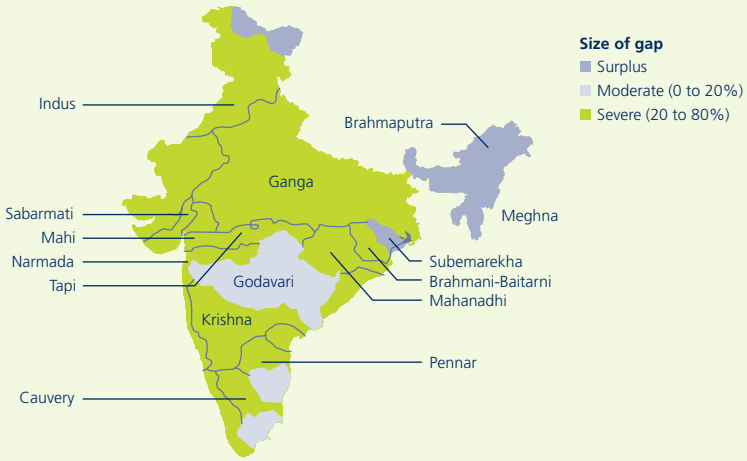
Water demand in India will grow to about 1.5 trillion m^3 in 20 years' time. Currently, agriculture is responsible for 80 percent of India's water demand and this will still be the dominant sector in 2030.

As more than 95 percent of India's agricultural production is and will continue to be for domestic consumption, the rapid population growth, coupled with rising income supporting the increasing caloric intake and meat consumption, are both key drivers underlying the water resource challenge. Agricultural demand for the precious liquid is estimated to double during this time period. Projected municipal and domestic water demand will also double in 2030, to 108 billion m^3, accounting for approximately 7 percent of total water demand. Demand from industry will also double to 196 billion m^3, accounting for 13 percent of water demand. This demand, weighed against today's accessible water supply, would create severe projected deficits for most of India's river basins.[53]

India's water supply

India's water supply is expected to reach approximately 740 billion m^3 in 2030, significantly short of aggregate demand of approximately 1.5 trillion m^3. India is a vast country with many river basins, including two of the world's largest rivers, the Ganges and the Brahmaputra.

Figure 26: Gap between existing supply and projected demand in 2030 (percent of 2030 demand)
The unconstrained projection of water requirements under a static policy regime and at existing levels of productivity and efficiency
Source: 2030 Water Resources Group: Charting our Water Future, 2009.



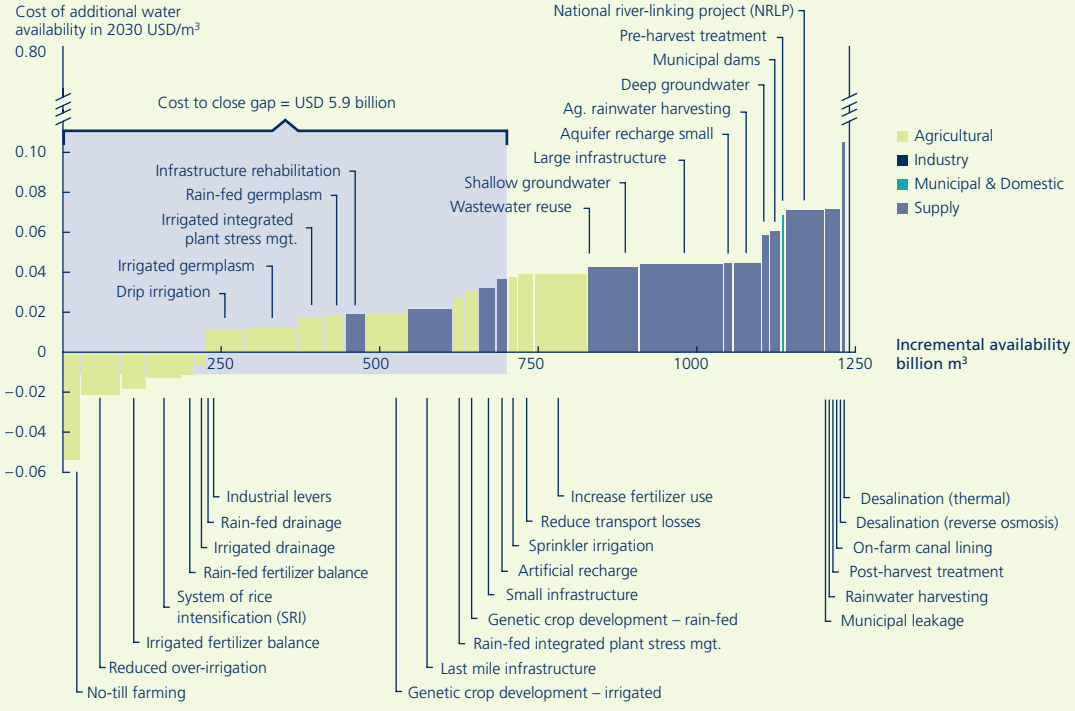
[53] 2030 Water Resources Group: Charting our Water Future, 2009.

Average annual precipitation received by the country is about 4000 km³ and of this, exploitable water resources amount to about 1900 km³. According to the FAO Aquastat 2010, the current surface and groundwater water resource base is estimated to be about 1880 km³, of which 418.5 km³ is groundwater. The number is highly variable because of the monsoon season, which brings roughly 80 percent of the annual precipitation. With increasing climate variability, Indian monsoons are becoming less predictable and the frequency of extreme events like droughts and floods has increased over the past decades.

Due to poor government policies and insufficient infrastructure, surface water is unable to meet India's total water requirement. Groundwater is virtually free (pumping costs only, with electricity being highly subsidized by the government). This inefficiency results in overextraction of the groundwater. Groundwater supply differs substantially by region. In the western rivers, the truly renewable groundwater supply is much less than what is actually pumped, leading to massive overdraft, declining water tables and elevated pumping costs; while in basins such as the Eastern Ganges additional groundwater supply could be increased sustainably. The availability of groundwater is compounded by rapidly deteriorating water quality in many areas of the country by agriculture and industrial pollution.

India has only 200 m³ of water storage capacity per person, compared to 2200 m³ per person in China and 6000 m³ per person in the U.S. The ability of the current infrastructure to buffer that variability is low, making it difficult for accessible water supply to meet projected demand.

Figure 27: India – Water availability cost curve
Source: 2030 Water Resources Group: Charting our Water Future, 2009.



As the distribution of water supply is uneven across the subcontinent, a basin such as the Ganga accounts for a large portion of accessible water supply, about 311 million m^3. Yet – at the same time – the Ganga basin also has the highest water demand resulting in the largest gap of 350 million m^3, followed by the Indus basin and Krishna basin with gaps of 106 million m^3 and 90 million m^3, respectively.

Closing the gap

A 2009 study published by the 2030 Water Resources Group lists 37 levers to close the water availability gap by 2030, ranked according to the related cost. Using the cheapest solutions will result in an annual investment of USD 5.9 billion, much less than the estimated total annual expenditure of USD 12.3 billion in 2007 for the total water sector.

About 80 percent of the cheapest solutions to close the base case demand-supply gap lie in improving agriculture's water efficiency and productivity. The remaining 20 percent of solutions to close the gap lie in additional supply solutions such as desalination plants, rehabilitation of existing infrastructure and last-mile canals.

To meet the implied demand for food and feed in the country (only 4 percent of India's agricultural production is exported), about 31 million hectares of additional irrigated land would be needed. As such, measures that increase the yields of fields, offsetting the need for additional land and additional irrigation are necessary. Agricultural yield can also be improved by making land more productive, including no-till farming, improved drainage, optimized fertilizer use or innovative crop protection technologies. Other major agricultural opportunities are further investment in genetic crop development, improved irrigation control and drip irrigation.

To the right side of the lever bar, we note that desalination projects, the National River-Linking Project and even the repair of municipal leakage are significantly more expensive than the solutions available in agriculture. However, for political reasons they may still rank higher on the governmental agenda.

In conclusion, the cost-effective solutions to address India's water challenge will require support from the national agricultural policy as well as technological innovation.

5 CONCLUSION: NEW INVESTMENT OPPORTUNITIES IN THE WATER SECTOR

5 Conclusion: New investment opportunities in the water sector

The importance of water as a life-sustaining resource will steadily increase over the next few years. As the global population continues to boom, pressure will mount on water resources that are already under enormous strain, and in many regions the traditionally careless use of water will have visible negative consequences.

- Consumers are therefore becoming increasingly aware that water is a precious resource that needs to be managed in a sustainable way. Technologies that promote more efficient use of water are already available: Water-saving domestic appliances, efficient industrial plants or low-cost methods for repairing pipes are just some of the practical ways of reducing water consumption. Enormous efforts are also being made in agriculture to try and improve the frequently wasteful utilization of water.

- These major challenges open up interesting opportunities for investors: Companies that grasp the increasing need for sustainable solutions as an opportunity – and respond by offering innovative solutions – can look forward to a sharp increase in demand in the years ahead.

- If we are to ensure sustainable management of water resources and avert a global water crisis, water must be given a price tag that accurately reflects its vital role in our lives. It is therefore the duty of politicians and lawmakers to lay down the relevant rules and to push through measures that promote more sustainable use of water. This change of mind-set has already occurred in those countries confronted with urgent water problems, whether in terms of quality or quantity, encouraging them to adopt the necessary laws, ordinances or budget allocations. But action is still needed at the political level, combined with a greater awareness by the general public of the importance of using water resources efficiently.

- To make successful investments in the water sector, investors therefore not only need to be informed about the latest technical advances and industry solutions, but must also closely follow developments and decisions on the political and legislative front. The introduction of new environmental standards, tougher demands on water quality, more public spending on infrastructure construction and maintenance as well as the fixing of tariffs and fees will have a significant impact on the growth of individual segments of the water market and, consequently, on the attractiveness of companies doing business in these segments.

- In the years to come, water will develop into a dynamic market of the future. Given the global trends that are shaping the water market, demand is unlikely to drop off in the long term. While due account needs to be taken of company valuations, investors with a long-term horizon can therefore expect to find numerous worthwhile and attractive investment opportunities.

WATER INVESTMENT TEAM

Water Investment Team

PORTFOLIO MANAGEMENT

Dieter Küffer, CFA
Senior Portfolio Manager
dieter.kueffer@sam-group.com
Phone: +41 44 653 10 73

Pieter Busscher
Portfolio Manager
pieter.busscher@sam-group.com
Phone: +41 44 653 10 56

RESEARCH

Daniel Wild, PhD
Senior Analyst
daniel.wild@sam-group.com
Phone: +41 44 653 12 37

Marc-Olivier Buffle, PhD
Senior Analyst
marc-olivier.buffle@sam-group.com
Phone: +41 44 653 12 06

Urs Diethelm, CEFA
Senior Analyst
urs.diethelm@sam-group.com
Phone: +41 44 653 10 10

Junwei Hafner-Cai, CIIA
Analyst
junwei.hafner-cai@sam-group.com
Phone: +41 44 653 12 35

YOUR CONTACTS

Professional Investors
clientservicing@sam-group.com
Phone: +41 44 653 11 11
Fax: +41 44 653 10 80

Private Investors
info@sam-group.com
Phone: +41 44 653 10 10
Fax: +41 44 653 10 80

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SAM
Josefstrasse 218 · 8005 Zurich · Switzerland
Phone +41 44 653 10 10 · Fax +41 44 653 10 80
info@sam-group.com · www.sam-group.com

SAM Sustainable Asset Management USA, Inc.
909 Third Avenue · New York, NY 10022
Phone +1 212 908 0188 · Fax +1 212 908 9672
info@robecoinvest.com · www.robecoinvest.com

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