

October 2007

SRI Focus

Water – increasing demand, diminishing supply

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Introduction

Against a background of increasing demand for water, the 2006 United Nations World Water Development Report suggests that, “in many parts of the world, available water quantity is decreasing and quality is worsening”.

The growth in demand reflects a growing global population combined with rising consumption of water by agriculture and industry. Alongside this, increasing levels of pollution plus the impacts of climate change are affecting water supply. Integrated and sustainable management of water resources is needed to ensure the world has enough water, of adequate quality, to satisfy the growing demand of many stakeholders. As water becomes increasingly scarce, tensions are likely to arise among different users, both within countries and across borders. Companies are beginning to compete for this essential resource. Preservation of biodiversity and ecosystems is a further requirement of the need to sustainably manage water resources.

This report looks at water supply and demand imbalances. Different ways for business to improve demand management and enhance supply are discussed. China is highlighted as a current example of the urgent need to respond to this issue. Finally, Newton assesses how some of the companies that it is invested in, on behalf of its clients, are responding to this issue.

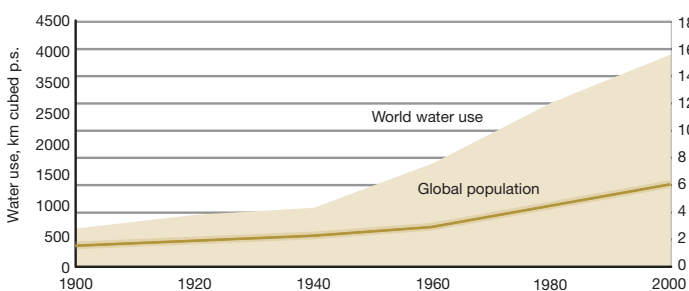
The location of fresh water resources

Saltwater oceans hold 97% of the Earth’s water resources. The remaining 3% is fresh water. Of this fresh water, approximately two thirds is held in the form of ice, in glaciers, polar ice caps and as permanent snow. Therefore, only c. 1% of the Earth’s water is available as fresh water for human consumption, including use in agriculture and industry. This fresh water is located in underground aquifers, in natural lakes and rivers, in man-made storage facilities and as precipitation. The water used by society is recycled over and over as it moves through the hydrologic cycle (see Appendix 1).

Increasing demand

Globally, water use is increasing (see Figure 1: Global water use and population). Demand for fresh water is expected to continue to grow, driven by population growth, urbanisation, technological advance and the drive to improve access to water.

Figure 1: Global water use and population



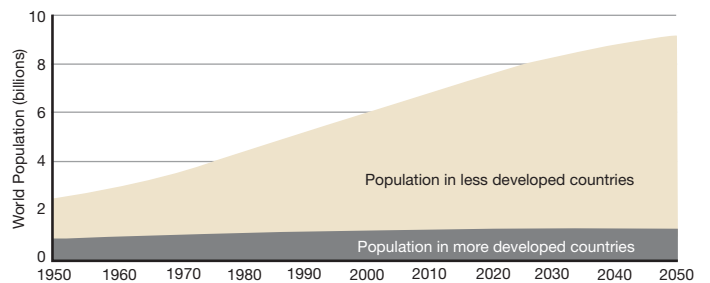
Source: Credit Suisse, Water, 07 June 2007

Population growth

The population growth of the last century was immense. In the 40 years after 1950, the population of the world doubled from 2.5 billion to 5 billion. Just before the turn of the century, the 6 billion mark was breached. Present estimates are for the population to reach 8-12 billion before the end of the 21st century¹.

In 1960, 70% of the global population lived in less-developed regions. By 1999, the less-developed regions had grown to comprise 80%. It is expected that global population growth will continue to be driven by population growth in the developing countries (see Figure 2: Global population growth 1950-2050).

Figure 2: Global population growth 1950-2050

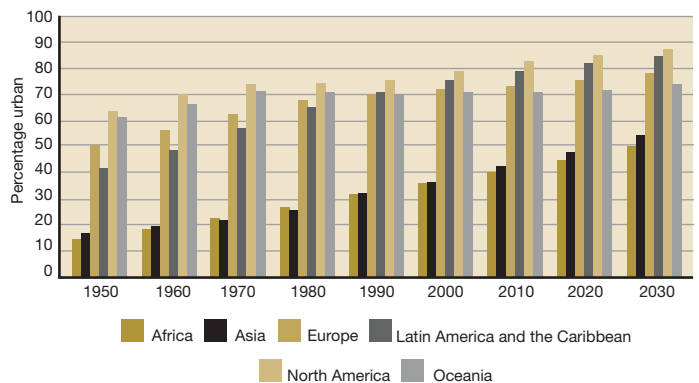


Source: United Nations. 2006. World Urbanization Prospects: The 2006 Revision (2007)

Urbanisation

According to the UNFPA², the proportion of people in developing countries who live in cities has almost doubled since 1960, from less than 22% to more than 40% in 2001. In more developed regions, the urban share has grown from 61% to 76% over the same period. This trend continues (see Figure 3: Percentage of population at mid-year residing in urban areas, by region – 1980-2030). In 2008, it is projected for the first time in history, 3.3 billion people, more than half of the world’s population, will be living in towns and cities. By 2030, the UNFPA expects this to swell to almost 5 billion. With urbanisation, the delivery of adequate, clean, and reliable supplies of fresh water becomes an important challenge. Further, cities begin to compete with the environment and the agriculture industry for water resources.

Figure 3: Percentage of population at mid-year residing in urban areas, by region, 1950-2030



Source: United Nations. 2006. World Urbanization Prospects: The 2005 Revision, Table A.17. New York: Population Division, Department of Economic and Social Affairs, United Nations.

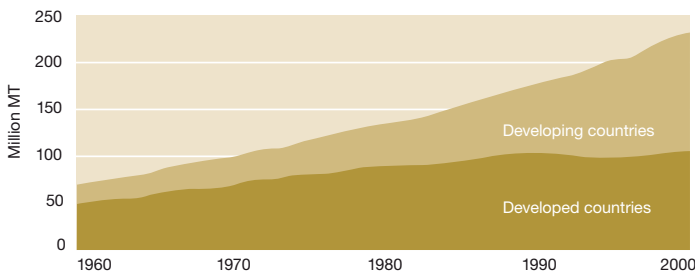
¹ Source: Global Change: Population Growth Over Human History, 01/04/2006

² The United Nations Population Fund (UNFPA) is a subsidiary of the UN General Assembly. The fund provides reproductive health support in response to country requests, helping to integrate population and reproductive health concerns into development initiatives.

Rising real incomes in emerging economies

Urbanisation is associated with lifestyle changes such as improvements in standards of living and education, better nutrition, sanitation, health practices, and medical care. As disposable incomes grow, demand for quality, variety and convenience is fuelled. Water demand is impacted through, for example, the change in diets that takes place as countries move up the income scale. Diets, which have traditionally been high in carbohydrate-rich cereals, shift towards higher-value and more water-intensive products such as meats, fruits and vegetables (see Figure 4). Rising incomes also fuel demand for manufactured goods, which require water during their manufacture (see Figure 5).

Figure 4: Changes in meat production in developed and developing countries, 1960 - 2000



Source: Business in the World of Water: Water Scenarios to 2025, World Business Council for Sustainable Development, August 2006.

Figure 5: Water production requirements

Water requirement (L)	Production
200	1kg of rice
500	1kg of potatoes
53	1 orange
250	1 pint of milk
450	1 egg
550	1 loaf of bread
18,000	1kg of butter
5,300	1kg of cotton
150,000	1 car
75	1 computer chip

Source: Waterwise, Stanford University, Financial Times, 18 August 2006

Technological advances increase accessibility

Advances in the technology of water pumps, networks and pipelines, have made water increasingly accessible for households and industry. Such advances have enabled groundwater to be pumped from greater depths. However, in many countries, this has led to rapidly declining water tables and critically depleted aquifers. Advances in technology have also led to the construction of dams, the intentions of which have been to provide greater access to water. Though damming may increase water accessibility in some circumstances, large-scale projects have often been associated with negative environmental and social impacts. This can result in less water being available. For example, in Egypt, the construction of the Aswan dam has caused the Nile Delta to shrink³.

Drive to improve access

Water shortages already exist in many regions. The World Health Organisation states that “more than 2.6 billion people, over 40% of the world’s population, do not have access to basic sanitation, and more than one billion people still use unsafe sources of drinking water”.

There is a global drive for universal access to water supply and services. In 2000, the international community set itself eight goals to achieve by 2015. These goals were termed ‘The Millennium Development Goals’ (MDGs). The MDGs include targets on, for example, eradicating extreme poverty, combating HIV/AIDS and malaria, and ensuring that every child receives primary education. Another of the goals is to ‘Ensure Environmental Sustainability’. This includes the specific goal of reducing, by half, the proportion of people without sustainable access to safe drinking water.

Diminishing supply

The strain on the world’s water resources is compromising water security for both individual consumers and industries. In many areas, the variety of demands on water resources is leading to a rapid deterioration of natural ecosystems. Countless communities depend heavily on rivers, both for direct water use and as a source of energy. However, rivers are running dry, lakes are disappearing, and water tables are dropping (See Figure 6: Selected examples of strained aquatic systems), mainly due to damming, water diversion and excessive withdrawals. In China, India, the US and Australia, aquifers are being depleted faster than they can be replenished. More than half of Europe’s cities are exploiting ground water at unsustainable rates⁴.

Figure 6: Selected examples of strained aquatic systems

Rivers running dry – Some of the world’s largest rivers, including the Nile, Ganges, Amu Darya and Syr Darya, the Yellow River and the Colorado River now run dry for part of the year. Little, if any, of the fresh water within these rivers reaches the sea.

Disappearing lakes – In Central Africa, Lake Chad has shrunk by c. 95% over the last four decades. In China, almost 1,000 lakes have disappeared in the Hebei Province alone.

Aquifer depletion – Water tables are falling in several of the world’s key farming regions. Examples include the North China Plain, which produces nearly one third of China’s grain harvest, the Punjab region in India, known as India’s breadbasket, and, the southern Great Plains of the US, a leading grain-producing region.

Source: Earth Policy Institute and Newton Investment Research

The water supply situation is further aggravated by pollution and the impacts of climate change.

³ Credit Suisse, Water, 07 June 2007

⁴ Credit Suisse, Water, 07 June 2007

Pollution

Water pollution can be derived from a variety of sources such as, failure to clean industrial waste, surface water run-off from agriculture or inappropriate discharge of sewage. Over-extraction of groundwater to depths where naturally occurring poisons may be present, such as arsenic, can also contaminate supplies. Levels of pollution are arguably worse in developing markets where preventative legislation, as well as appropriate water treatment capacity, may not be in place. For example, an estimated 90% of wastewater in developing countries is still discharged directly to rivers and streams without any waste processing or treatment⁵.

Climate change

Water systems face new challenges as a result of the impacts of climate change. The Stern Review on The Economics of Climate Change, published in October 2006, stated that:

“People will feel the impact of climate change most strongly through changes in the distribution of water round the world and its seasonal and annual variability.”

The potential impacts on the water cycle as a result of climate change have been widely debated. It is generally agreed that water vapour concentrations, clouds and precipitation patterns may be impacted. However, many uncertainties remain and current climate models suggest contradictory results regarding the future distribution of precipitation. However, extreme and unpredictable weather events, whether they are attributable to climate change or not, have the potential to affect significantly both availability and quality of water. Hurricane Katrina passed to the east of New Orleans on August 29th, 2005. Though it did not strike the city directly, by August 31st, 80% of New Orleans was flooded, with some areas under fifteen feet of water. Saltwater and surface contaminants entered aquifers contaminating sources of drinking water. In July this year, the UK experienced severe flooding where up to 150,000 properties either lost, or were at risk of losing, mains water following flooding of the Mythe water treatment works at Tewkesbury.

Rising sea levels pose an additional risk to water supplies held in man-made storage facilities. A primary cause of rising sea levels is the increased mass of water entering the ocean by the melting of ice sheets and glaciers. There is increasing scientific evidence to suggest that Arctic sea ice is retreating at a record rate. Along with natural variability, rising concentrations of greenhouse gases and their related impact on temperatures across the arctic region, are often cited as a main factor in the loss of ice. In August 2007, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and the Japan Aerospace Exploration Agency (JAXA), which have been tracking Arctic ice levels by satellite since 1978, announced that the area of the Arctic Sea covered by ice was at its lowest level ever recorded. The US National Snow and Ice Data Centre (NSIDC)* also reported similar findings in August this year.

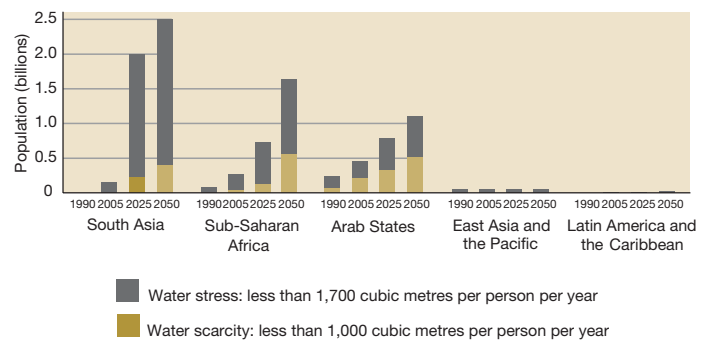
*NSIDC is part of the Cooperative Institute for Research in Environmental Sciences at the University of Colorado. It receives support from NASA, the National Oceanic and Atmospheric Administration and the National Science Foundation.

Water stress and water scarcity

Water stress is a term used when there is not enough water for agricultural, industrial and domestic use. The World Business Council on Sustainable Development suggests that when annual per capita renewable freshwater availability is less than 1,700 cubic meters, countries will suffer from occasional or persistent water stress. If this water levels falls below 1,000 cubic meters, economic development and human health will be impacted.

Currently, roughly 50 countries, with approximately one third of the world's population, suffer medium or high water stress. 17 of these extract more water annually than is recharged through their natural water cycles⁶. The Middle East, Central Asia, North Africa, South Asia, China, Australia, the western United States, and Mexico are especially prone to water shortages. Water stress is predicted to accelerate in intensity in several regions (see Figure 7). The World Health Organisation (WHO) estimates that, by 2025, nearly 2 billion people will be living in countries or regions with absolute water shortages. In effect, this means that water resources, per person, fall below the recommended level of 500 cubic metres per year. This is the amount of water a person needs for a healthy and hygienic life, as defined by the WHO.

Figure 7: Water stress is predicted to accelerate in intensity in several regions



Source: Human Development Report 2006: Beyond Scarcity: Power, Poverty and the Global Water Crisis

To manage this trend, countries need to embark on large and expensive water-development projects. Additionally, efficient management of water demand and supply, combined with modern technology, can significantly maximise the use of scarce water supplies.

5 Source: Human Development Report 2006: Beyond Scarcity: Power, Poverty and the Global Water Crisis

6 As stated on Wikipedia: <http://en.wikipedia.org/wiki/Water> – accessed on 30/09/2007

Inefficient use of water

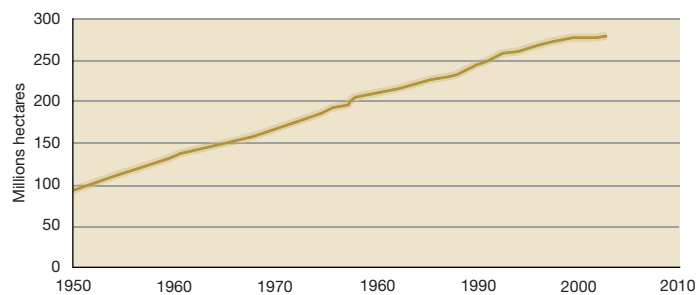
Nearly 70% of global water withdrawals from rivers, lakes, and aquifers are used for agricultural irrigation. Industry accounts for c. 22% of the extraction and households account for c. 8%⁷. Currently, there are significant inefficiencies in the way water is used.

Agricultural inefficiencies

The statement that irrigation uses, as a global average, 70% of all consumable water, disguises wide variations. For example, in the wet UK, water used for agriculture accounts for less than 1% of consumable water. However, in Spain, Portugal and Greece, irrigation water exceeds 70% of the total consumable water. In many developing nations, water required for irrigation exceeds 90% of available water resources⁸.

Much of the growth in water use over the past half-century has come from an increase in irrigation. According to the Earth Policy Institute, irrigated area, on a global basis, almost tripled between 1950 and 2003 from 94 million hectares to 277 million hectares. However, this growth is showing signs of tapering off, most likely because water needed for the expansion of irrigation, is becoming increasingly scarce (see Figure 8: World Irrigated Area, 1950 – 2003). However, as agriculture becomes a supplier of energy through the growth of feedstocks for biofuels, demand for irrigational water is likely to increase.

Figure 8: World Irrigated Area, 1950–2003



Source: Earth Policy Institute – World's Water Resources Face Mounting Pressure, 26 July 2006, Elizabeth Mygatt.

The United Nations Environment Programme (UNEP) estimates that 31% of water used for irrigation is wasted. This means that, of the water withdrawn from its source for the purpose of irrigation, only 69% is absorbed by the plants. Another estimate indicates that as much as 60% of the total water pumped is wasted before it reaches the intended crop⁹. Therefore, measures to improve efficiency could make a significant difference to aggregate world water demand.

Drip Irrigation

Drip irrigation is a form of efficient irrigation where water is applied slowly to the roots of a plant either by depositing water on the soil surface or directly onto the plant's roots. Drip irrigation typically gives higher crop yields and requires less water. For example, in Himachel Pradesh, in India, drip irrigation of apple trees has been found to increase fruit yields by 10-45%, while water usage has declined by 25%.¹⁰

Earlier in the year, Newton, on behalf of its clients, invested in an Indian provider of drip irrigation systems, Jain Irrigation.

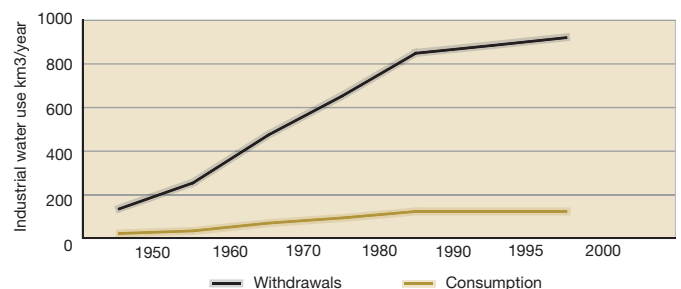
Water availability is predicted to be a factor limiting future food production. To satisfy the growing global population and associated increased demand for food, production of food crops in developing countries is projected to increase by 67% between 2000 and 2030¹¹. To achieve this, the agriculture sector needs to produce more food, of better quality, while using less water per unit of output.

Industrial inefficiencies

Water is used by industry in a myriad of ways. For example, it is used for cleaning, heating, cooling, for generating steam, as a solvent and as a constituent part of the product itself, such as in the beverage industry. Water also plays a key role in energy generation and transportation.

Following major growth between 1960 and 1980, global water withdrawal for industrial use has stabilised, despite continued growth in manufacturing production. However, according to the United Nations, industry could cut usage by 40-90% through use of existing technology.

Figure 9: Total world industrial water use, 1950–2000



Source: United Nations Educational, Scientific and Cultural Organisation (UNESCO): The 2nd UN World Water Development Report: 'Water, a shared responsibility', March 2006.

7 Credit Suisse, Water, 07 June 2007

8 UBS: The defining crisis of the 21st century, 10 October, 2006

9 http://www.globalchange.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html – accessed on 30/07/2007

10 Credit Suisse, Water, 07 June 2007

11 United Nations Educational, Scientific and Cultural Organisation (UNESCO):

The 2nd UN World Water Development Report: 'Water, a shared responsibility', March 2006.

Inefficient governance (developing world)

Environmental governance can help to ensure that growing industries undertake an appropriate level of environmental management. Legislation to limit pollution of water resources has long been in place in the US, Europe and other developed markets. Major pieces of legislation include:

- **The UK Control of Pollution Act 1984.** It is a criminal offence to pollute a lake, river, ground water or the sea, or to discharge any liquid into such water bodies without proper authority.
- **The US Clean Water Act of 1977.** This established the basic mechanisms for regulating contaminant discharge. It established authority for the Environmental Protection Agency (EPA) to implement wastewater standards for industry.
- **The EU Integrated Pollution Prevention and Control Directive (1996).** The Directive imposes a requirement for industrial and agricultural activities, with high pollution potential, to have a permit which can only be issued if certain environmental conditions are met. Therefore, companies themselves bear responsibility for preventing and reducing any pollution they may cause. The Directive has been mandatory for all new installations since 1999. However, by October 2007, this legislation comes into force for all existing installations.

Further, there are many international conventions and multilateral environmental agreements that aim to regulate environmental pollution (see Appendix 2 for examples). However, legislation on responsible water use has been lacking in the developing world. Governments in some countries may suffer from inadequate water expertise and institutional capacity. There may also be a lack of the capital required for investment in water systems. However, public demand and economic necessity are creating increasing pressure for this to change.

The role of business

During most of the twentieth century, industrial access to water was taken for granted, even in regions with scarce supplies. In the coming decades, water supply and quality problems are likely to pose a direct threat to businesses. Companies may need to adapt to more stringent water quality regulations and an increasing public scrutiny of water-related activities. Additionally, growing community activism and control over local water resources may contribute to competition for limited supplies. Industries that require high quality water for the manufacture of products, such as the pharmaceutical or food processing industries, may be affected by declining water quality. These factors, in some areas of the world, are already affecting site selection, license to operate, productivity, costs and revenues.

However, opportunities for businesses also arise. Use of water resources and the associated costs can be reduced through more efficient water demand management. Further, the strain on water resources can be eased by the enhancement of efficient water supply mechanisms, such as in the design and use of water conservation and treatment technologies. Additionally, efforts to take responsibility for water management can enhance corporate image and public acceptance of a company's operations (see Appendix 3 for examples of Best Environmental Practice).

Successful water management has far-reaching benefits for industry, communities and the environment. The tables below highlight areas where businesses can have a positive impact.

A) Water Demand Management

Improvements needed:	Comments:
<p>Agricultural efficiency</p>	<p>Improving the efficiency of water use in agriculture can be achieved by:</p> <p>More efficient irrigation techniques, such as drip irrigation. The use of efficient irrigation varies widely between countries. In China, only 2.8% of arable land is irrigated by efficient irrigation methods. In India, this figure is only 1.6%. However, in Germany and Israel 100% of arable land uses efficient irrigation methods. Countries such as India and China provide significant opportunities to improve agricultural productivity through the use of efficient irrigation.</p> <p>Cultivation of drought resistant and high-yield crops. By improving the water utilisation rate and efficiency of crops, water can be conserved while crop production is increased.</p> <p>Reducing water run-off from fields. Preventing water run-off can help reduce contamination of water supplies by decreasing the amount of agricultural chemicals that leave a field. Simply, this can be achieved by flattening the land.</p>
<p>Water infrastructure and networks</p>	<p>A significant percentage of distributed water never reaches the final user but is lost to leakage. There is significant variation in leakages between countries. For example, water lost due to leakage in Holland is estimated at 5%, in the UK it is estimated at 23%, in the US at 25% and in the Czech Republic at 33%. Such problems are most acute in long-established urban areas with ageing assets. Recently, leakage rates have fallen in response to higher water prices and a rising tide of public sentiment against wasted water. Credit Suisse estimates real growth in water infrastructure expenditure, on a global basis, at 6.7% per annum to 2025. Improving the efficiency of water infrastructure and network can be achieved by:</p> <ul style="list-style-type: none"> • Leak detection and prevention • Improved pipes and valves • New technologies • Better plumbing • More efficient appliances
<p>Water management strategies</p>	<p>Installation of water meters. Planning, allocating and managing water resources can only be undertaken effectively if water use patterns are known. The installation of water metering devices allows such assessment. Once water use information is gathered, companies can begin to ensure that water is being used appropriately.</p> <p>Matching water quality to use requirements. In many instances, the water used in industry is of an unnecessarily high quality, such as when an industrialised plant uses new water intake for the purpose of cooling. Such a use can often be met with lower quality water, thereby decreasing demand for new water withdrawals. Processes such as heating, cooling and quenching are the most common applications for lower quality water. Lower quality water can also be used as wash-down water and for site irrigation.</p> <p>Zero effluent discharge targets. Effective company policies, such as a zero effluent discharge targets, can prevent water contamination. It can also save costs by reducing the need for water treatment. Further, some used water contaminants can be collected, traded for their residual value and re-used.</p>

B) Enhancing water supply

Enhancement of supply by:	Comments:
<p>Water treatment</p>	<p>Wastewater is used water which may contain substances such as human waste, food scraps, oils, soaps and chemicals. Wastewater also includes storm run-off. Harmful substances that wash off roads, parking lots and rooftops can cause significant environmental damage and contamination of water supplies.</p> <p>Water treatment is a process that is undertaken to reduce or remove contaminants present in water. The objective is to make water more acceptable for a desired end use, including use of water as drinking water, use of water in industrial processes and use of water for medical purposes. Additionally, the objective may be to allow treated water to discharge into the natural environment without causing an adverse ecological impact.</p> <p>Business opportunities arise in the construction and management of wastewater treatment and reuse facilities. Treatment technologies, for example, membrane filtration and UV disinfection, provide other avenues for investment.</p>
<p>Use of reclaimed water</p>	<p>Reclaimed water is treated wastewater that is now suitable for reuse. Reclaimed water is also referred to as recycled water.</p> <p>Industrial uses of reclaimed water include cooling, power generation, boiler feed and quenching. In the construction industry, reclaimed water can be used for dust control, soil setting and compaction, aggregate washing and concrete production. In agriculture, reclaimed water can be used for irrigation. It can also be used for urban irrigation of parks, sports fields and golf courses. Domestic applications for reclaimed water include fire fighting, car washing, toilet flushing and garden watering.</p> <p>Businesses can introduce on-site industrial water recycling processes in areas where the quality of freshwater is declining locally, or where freshwater supplies are becoming unreliable. The Israeli government has plans in place for water recycling to deliver 25% of water supply. The Australian government has plans in place for water recycling to deliver 11% of water supply.</p>
<p>Desalination of seawater</p>	<p>Desalination is the production of fresh water through the removal of salt from seawater or brackish water.</p> <p>The process of desalination typically requires large amounts of energy as well as specialised, expensive infrastructure. However, the large energy reserves of many Middle Eastern countries have allowed for desalination to be employed in those areas. Saudi Arabia's desalination plants account for about 24% of total world capacity.</p> <p>Global Water Intelligence, in its report titled Desalination Markets 2007: A Global Industry Forecast, projects that the global desalination industry is set to grow from 39.9 million cubic meters per day at the beginning of 2006 to 64.3 million cubic meters per day in 2010.</p>

Should the price of water rise?

Water is often wasted because it is under-priced. There is a significant cost associated with collecting, distributing and treating water. However, direct and indirect subsidies, especially in agricultural use, are still common in both developed and developing countries. Removing such subsidies and letting water prices rise can provide incentives for conservation and for the investment needed to spread more efficient technologies.

Comment from Newton's Utilities analyst: Robert Canepa-Anston

Of all the services in the utility sector, water is the most political. In contrast to gas, electricity and telephones, state ownership of water assets remains high. In America, for example, while the electricity sector has been largely privatised, water utility ownership remains mainly in local municipal hands and is highly fragmented. What is obvious is the sensitivity surrounding the pre-eminent public good of the provision of clean drinking water. However, there is an inherent tension in public policy objectives. For example, the need to ensure investment in assets and services for the ongoing provision of water versus the need to ensure water's affordability for the most vulnerable in society. The temptation to allow affordability to dominate has sometimes led to returns for water companies being squeezed to unattractive levels. This, in turn, has led to under-investment.

Governments have begun to wake up to the necessity of setting proper price signals to discourage wastage given the increasing scarcity of the raw material in certain environments (very similar to the shift in energy policy away from a focus on affordability). The need to put up prices is also brought into sharp focus by the investment requirements that water scarcity (and its underlying causes) bring with it. Global warming is forecast not only to increase the dryness of the summer in certain regions, but also to increase the intensity of rainfall when it occurs. For example, Thames Water in the UK may potentially have to invest around £5bn to upgrade

London's sewers to cope with severe heavy rainfall and to build a new reservoir to ensure reliability of supply year round. This investment is almost the same value as the company's current asset base. All this should be positive for investors in such assets – poor levels of profitability will not be an option going forward.

Large price rises bring the requirement on companies to explain to their customers why bills are going up. For example, in the UK, South West Water's management made extensive appearances in the media around the last major price rise to explain why the increase was required. For some, convincing consumers is a more difficult challenge. One particular area is sewage treatment: in certain countries it has been collected from households for years at very low cost. Now the investment needs to be made to properly treat the sewage before its final disposal. However, consumers and regulators in certain countries have been reluctant to see price rises when the reason doesn't benefit them directly. The EU's water framework directive raises this issue closer to home: it poses the big question of how much of the costs of cleaning up man-made water pollution should fall on water customers in contrast to farmers, road users, or industry.

When looking at an investment in a water utility, robustness of the regulatory framework without conflicting policy goals, is key. Affordability makes the investment less vulnerable to political risk, while a clear history of being able to impose above inflation price increases gives confidence that the regulator can carry out its role. After that, it's down to company specifics and valuation.

Country Focus: China

China has 20% of the world's population but only 6% of its freshwater resources on a per capita basis¹². Since 1979, China has been the world's fastest growing economy. Poverty has fallen sharply and education and health have improved at a significant rate. However, rapid growth has strained China's water resources. Current projections indicate that demand for water will rise a further 20% by 2030¹³.

Together, the industrial and agricultural sectors account for 85% of China's total water consumption. However, the impacts of urbanisation (see Figure 10: Urban Population in China, 1995 – 2005), rising incomes (see Figure 11: GDP and GDP Per Capita in China, 1995 – 2005), food needs and climate change are further contributing to strains on water infrastructures and resources. According to the Chinese Ministry of Water Resources, about 400 of China's c. 600 cities, are short of water.

Figure 10: Urban population in China, 1995–2005

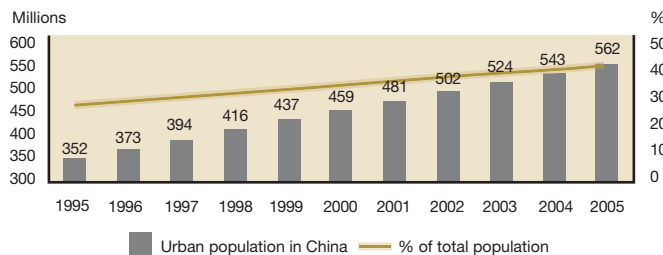
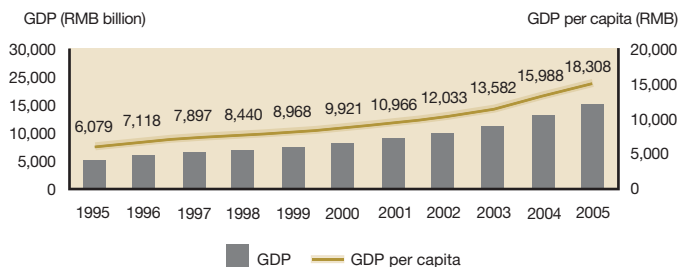


Figure 11: GDP and GDP per capita in China, 1995–2005



The World Health Organisation estimates that 90% of China's rivers are polluted. According to international standards, c.60% of water in China is undrinkable¹⁴. 9000 chemical plants line the Yangtze River¹⁵. It has been reported that in 2005, over 38 billion tonnes of wastewater flowed into the Yangtze, Yellow and Huai Rivers. In 2005, 278 cities reportedly had no sewage treatment plants and only 52% of sewage produced by China's largest cities was treated¹⁶. China's Construction Ministry estimates that US\$130bn will need to be invested in water infrastructure between 2006 and 2010 to meet the target of increasing the proportion of sewage that is treated from 34% to 40%, by 2010.

The consequences of this environment were outlined in a study conducted by the Organisation for Economic Cooperation and Development (OECD), at China's request. The findings of the report were presented in July 2007. The Study found that that as many as 300 million people are drinking contaminated water every day. It also found that 190 million people are suffering from water-related illnesses, each year. Water pollution is now posing a significant challenge to the government and to social stability.

To promote the more effective use of water, the Chinese government, in its 11th Five-year Plan (2006–2010), outlined targets to:

- Decrease water consumption per unit of GDP by 20%;
- Reduce the leakage rate to 15%;
- Improve irrigation efficiency 5%; and
- Recycle 20% of sewage volume in northern China, and 5–10% in Southern China.

In recent months there has been a significant amount of press coverage highlighting the extent of China's water pollution problem. Headlines include:

Chinese regulator tells banks to shun polluters

Reuters, 13 July 2007

China adopts strict water pollution measures

Worldwatch Institute, 10 July 2007

Multinationals accused of fouling waters in China

Forbes, 23 August 2007

China drafts new law to curb pollution

Reuters, 26 August 2007

Water pollution endangers 200 million in China

The China Post, 28 August 2007

Environmental watchdog closes 400 companies

The Sydney Morning Herald, 4 September 2007

The articles highlight efforts being taken by the government to tackle the problem. Actions include:

¹² Source: CIA World Factbook, AQUASTAT, UBS SRI Research: Trends and Changes, 25/09/07
¹³ Source: Human Development Report 2006: Beyond Scarcity: Power, Poverty and the Global Water Crisis

¹⁴ UBS Investment Research: Chinese Water Utilities, 19 September 2007

¹⁵ JP Morgan's Hands on China Series: Presentation – Peter Gleick, April 2007

¹⁶ Watershed: The specific land area that drains water into a river system or other body of water. Defined by UNESCO – the United Nations Educational, Scientific and Cultural Organization

- The China Banking Regulatory Commission has called on banks to withdraw lending to firms listed by the National Development and Reform Commission as heavy polluters or operating with inefficient, outdated facilities. This follows an order made by the central bank, a week previously, for commercial banks to stop lending to polluting producers and to call in existing project loans that may be deemed undesirable by the government.
- A “Watershed Permit Restriction” has been placed on permits for new industrial projects in 13 cities and development zones. The watersheds located near to these city’s and development zones are currently suffering from ‘serious’ pollution levels. The watersheds are the Yangtze, Yellow, Huai and Hai Rivers.
- The Chinese government has begun a naming and shaming campaign on companies that fail to comply with environmental regulations. In August, the Institute of Public and Environmental Affairs released a list of 90 multinational companies that have been found by environmental protection authorities to have violated water pollution regulations since 2004.
- In August, Chinese lawmakers were deliberating a draft amendment to the Water Pollution Prevention and Control Act. The amended law aims to remove a 1 million yuan (c. US\$160,000) cap on fines for water polluters and would allow penalties of 20% to 30% of the direct economic losses caused by a spill or pollution. Further, environmental protection officials who fail to set up a water pollution emergency response scheme, or delay reporting and hide water pollution accidents, would face administrative punishment and possible criminal charges.
- In September, it was reported that China’s environmental watchdog had closed down 400 companies for failing to tackle water pollution. A further 762 companies and projects had been suspended or fined due to environmental violations.
- The State Environmental Protection Administration (SEPA) has been designated as the lead authority to audit pollution-prone companies that are seeking to list on the Chinese stock market. SEPA’s findings will be submitted to the China Securities Regulatory Commission, which gives final approval on stock market listings and secondary share issue applications. Currently, as part of listing requirements, companies must meet national and local pollution discharge standards and have an “advanced level” of pollution control in their respective sectors. Companies must also have a 100% compliance rate for submitting documentation on environmental impact assessments regarding plant construction, renovation or expansion. Further, pollution-control facilities must attain a 95% operating rate while all pollution charges must be paid as required.

The developments in China provide an example of how decreasing water availability can directly impact industry. Access to potential manufacturing sites is now limited. For potentially eligible manufacturing sites, there is uncertainty about standards and planning. Further, there is increasing difficulty in obtaining and maintaining water permits. Competition for water between agriculture, industry, cities and the environment is increasing. Additionally, the declining water quality is leading to higher pre-treatment costs and new capital expenditure for water treatment technology. Improvements in water use efficiency by the agricultural sector, as well as industry, are required to conserve water. New forms of investment are needed particularly in the areas of pollution control and water treatment technology.

Companies with operations in China now need to be taking measures to reduce water risks. Assessment of the water landscape and associated risks must be undertaken. Water use and wastewater discharge must be measured. In summary, for companies with operations in China, it is now imperative that water risk is factored into business decisions.

Company Involvement

What are the companies that Newton is invested in, on behalf of its clients, doing to improve world water supplies?

Newton assessed the water management strategies of 3 multinational companies that have operations in water stressed areas (see Table C: Water resource management strategies). Newton also looked at some of the water solutions provided by 2 of its investee companies (see Table D: Provision of water solutions).

C) Water resource management strategies

Company	Anglo American (AA)	Cadbury Schweppes (CS)
Sector	Mining	Food Producers & Processors
Recognition of the need to manage water use	<p>AA states that to use water more responsibly and efficiently it is constantly looking at ways to conserve, recycle, treat and preserve the purity of water. Water risks identified include:</p> <ul style="list-style-type: none"> • Pollution and inadequate supply can lead to conflict, fines and clean-up costs; • Water is a primary concern to many of the communities in which it operates; • Water costs are rising; • Flooding can impact safety and production. 	<p>CS acknowledges its dependence upon the supply of water, as both confectionery and beverages use water in the production processes. Therefore, CS has committed to group-wide targets for manufacturing sites to reduce the amount of water used and wastewater discharged, by 10%, from 2006 to 2010.</p>
Actions to manage water demand	<p>AA is undertaking a capital expenditure programme in order to lower the number of water pollution incidents. This involves:</p> <ul style="list-style-type: none"> • An investigation of all sewage pump systems in order to assess where action is required for the prevention of spills/leakages; • Focusing on improving water management systems, including ensuring that all business units have updated water information systems; • AA is also undertaking an analysis of the impacts of its operations on water catchments. 	<p>CS water strategy is still in the early stages of development but the intention is to ensure that all water scarce sites have reduction programmes in place. Such programmes would include initiatives to save water by:</p> <ul style="list-style-type: none"> • Installing rain water harvesting infrastructure for water use in toilet flushing, cooling towers, boilers and gardens; • Investing in water meters; • Adopting zero water discharge targets. <p>Additionally, the company is already undertaking measures to save water such as through the implementation of leak prevention programmes and the addition of flow pressure reducing devices.</p>
Actions to enhance water supplies	<p>AA is continuing progress on the construction of water treatment plants for mines. The company is also undertaking several projects in arid regions. For example, in the Atacama Desert in Chile, a project is being undertaken to harvest water from mist traps. The water is being used to grow vegetables and promote tourism in the area. Additionally, the company is undertaking some water-reuse initiatives. For example, in an area of South Africa, the company is participating in a project that involves desalinating and purifying subterranean water and pumping it through a new underground network to the local municipality. The project is expected to provide 20 megalitres of clean water per day. This will meet c.20% of the local community's current water requirements. AA also states that it is exploring ways to use wastewater in production processes.</p>	<p>CS states that its overriding aim is to minimise the environmental impact of its water usage. This is achieved through treatment and recycling of wastewater and implementing plans to reduce the amount of wastewater.</p>
Adherence to Best Environmental Practice	<p>AA has committed to:</p> <ul style="list-style-type: none"> • Full ISO 140001 certification for its materials operations. At the end of 2006, the company had achieved 86% certification; • Revise all water definitions and policies in line with emerging best practice and reporting guidelines, during 2007; • Provide guidelines for the production of integrated mine water management plans that will be rolled out across the group (no time frame given). 	<p>CS, in 2004, updated its Environment, Health & Safety standards to be in line with those of ISO 140001 and OHSAS 180001. The company aims to have fully implemented and embedded these standards, in all its manufacturing sites, by 2008.</p>
Supply chain vulnerability	<p>AA aims to ensure that a commitment to sustainable development is made throughout its value chain. This includes the management of water resources.</p>	<p>CS states that it works with its suppliers and business partners to improve collective Environmental, Health & Safety performance, including the protection of ecosystems impacted by the provision of raw materials for products.</p>

Company	SABMiller (SABM)
Sector	Beverages
Recognition of the need to manage water use	<p>Many of SABM's brewing operations are located in water stressed areas. The company is committed to the implementation of water management practices, throughout its global operations, that take account of local, geographical, environmental and social practices. SABM is also committed to, on a case-by-case basis, direct investment towards improving access to reliable water supplies in the communities in which it operates.</p> <p>SABM acknowledges that it's not only the water used in the brewing process that is important. Therefore, in 2006, the company committed to looking at its total water footprint. This involved assessing water use in growing crops, in packaging production, water use as a raw material and reuse of wastewater, post the beverage production process.</p>
Actions to manage water demand	<p>SABM is in the process of undertaking efforts to map the watershed risk relating to its operations. The objective is to: Assess current and future water availability and quality including consideration of changes in projected population growth, farming and industrial usage demands and as well as potential climatic changes;</p> <ul style="list-style-type: none"> • Understand water use and projected demand in the context of availability of local water resources; • Identify potential areas for watershed protection. <p>Additionally, SABM commits to:</p> <ul style="list-style-type: none"> • Manage internal water consumption efficiencies, optimising the amount of water used to produce a unit of product; • Adopt internal water reduction targets; • Undertake regular equipment maintenance; • Improve awareness of waste minimisation initiatives; • Improve water-monitoring processes.
Actions to enhance water supplies	<p>Currently, 98% of wastewater produced by SABM is either treated on site or safely discharged, mainly to third parties, for treatment. For the remaining 2%, SABM states it has detailed action plans in place for the management of wastewater. SABM commits to:</p> <ul style="list-style-type: none"> • Use recycled water in cleaning processes; • Consider rain-water harvesting as a possible supplement to brewery raw water supply; • Ensure suitable water treatment options are available for facility wastewater and, where possible, establish possible uses for the treated wastewater, either on site or within the local community; • Ensure effluent quality, as a minimum, meets local legal requirements. <p>Additionally, SABM is gathering information on water availability and quality in the context of future requirements. For example, SABM is investigating issues such as crop irrigation and ground and surface water availability.</p> <p>Further, SABM is undertaking several projects to use biogas, a by-product of wastewater treatment, as an energy process.</p>
Adherence to Best Environmental Practice	<p>SABM states it is continuing to expand the number of sites with environment management system, based on the principles underlying the ISO 14001 standard or similar. By 2006, 84 sites had achieved formal, independent, externally certified systems. This had risen from 68 in 2006. Globally, SABM has over 160 brewing operations.</p>
Supply chain vulnerability	<p>SABM commits to sharing its principles on water management with its supply chain partners in order to: Stimulate and support water conservation by a broader section of the community;</p> <ul style="list-style-type: none"> • Help supply chain partners to improve efficiencies while at the same time reducing risks and costs; • Reduce the overall SABM water footprint. <p>Further, SABM has undertaken engagement with its supply chain partners to understand their use of water, in order to gain a better understanding of its overall water footprint.</p>

D) Provision of water solutions

Company	Bayer (Germany)	Veolia Environnement (VE) (France)
Sector	Chemicals	Other Utilities
Solutions for global water management	<p>Bayer CropScience is a global leader in crop protection and non-agricultural pest control, seeds and plant biotechnology. The aim of the products supplied by Bayer CropScience is to increase the productivity of crops, improve their quality, and reduce loss of yield due to pests, diseases and weeds. In this way, the company can contribute to making optimal use of natural resources like soil and water, thus creating an efficient agricultural basis for a healthy food supply. Bayer CropScience is involved in numerous projects to foster the efficient use and protection of water. Examples include:</p> <ul style="list-style-type: none"> • Providing solutions for healthy plants as these use water more efficiently; • The introduction of integrated water protection methods in the areas of research, development and product stewardship; • Encouraging land management programmes to support better water management; • Research into, for example, genetically engineered seeds for stress-tolerant plants that require less water. <p>Bayer MaterialScience is a supplier of high-performance materials and systems solutions used in a wide range of products for everyday life. It has developed a coating system that is used to reline damaged drinking water pipes on a permanent basis, thereby preventing leakage.</p> <p>Additionally, the company states it is constantly searching for means of further reducing water consumption in its own production processes. The company is also undertaking research projects on the protection of drinking water and freshwater.</p>	<p>VE's business is to provide solutions to problems in the areas of water, waste management, energy services and transportation.</p> <p>Veolia Water specialises in the outsourced management of water services for municipal and industrial customers. The company designs, builds and operates turnkey facilities for water and wastewater systems. The company aims to optimise the water cycles thereby enabling less use and protection of water resources. In other words, it withdraws water from the natural environment, produces and distributes drinking and industrial water, collects and transports wastewater and treats it in preparation for its recycling or release back into the natural environment. Veolia Water also works upstream to protect water resources, for example, by monitoring water quality, and, downstream to protect receiving environments, such as reducing leaks and waste and conserving resources. The company is also involved in:</p> <ul style="list-style-type: none"> • Developing alternative and innovative technologies, such as the recycling of treated wastewater for uses such as sprinkler systems, industrial processes or recharging aquifers. Veolia Water's technologies and expertise enables it to use reliable and cost effective solutions to produce drinking water from desalinated seawater. For example, it has recently gained a turnkey contract to supply a desalination plant. The plant will have a production capacity of 273,000 cubic meters/day and will be the world's largest Multiple Effect Distillation desalination plant. • Protection of water resources through the identification of chronic pollution as well as in the assessment of risks of accidental pollution of those resources earmarked for the production of drinking water. • Minimising abstraction of water resources. This is achieved primarily through responsibly managing demand and by identifying and reducing leaks in the water supply system. • Continuous monitoring of water resources to ensure the prevention of any possible threats. • Water conservation by tackling network leakage. The company has set a recurring target of 80% network efficiency in the EU 15. • Provision of metering systems. The aim of which was to help manage demand by placing responsibility in the hands of consumers and industrialists alike. 93% of water customers were equipped with a metering system in 2005.

Conclusion

The world's water resources are under pressure. Population growth, urbanisation and advances in water access technology are contributing to a significant increase in usage. Alongside this, declining water quality, combined with the impacts of climate change, is affecting supply. Continued and long-term access to water is a considerable challenge for companies, particularly those operating in areas of water stress. Both opportunities and risks are created.

Opportunities

The current inefficiencies in the way water is used create new business opportunities, particularly in the design of new technologies that:

- Improve water demand management. This can be achieved through, for example, more efficient irrigation techniques, improving water infrastructure and networks and matching water quality to water use requirements.
- Enhance water supply. This can be achieved through the treatment of wastewater, use of reclaimed water and desalination of seawater.

A company can also reduce operating costs by implementing measures to reduce water consumption. For example, by installing water meters and by implementing policies to reduce effluent discharge. In addition, efforts to take responsibility for water management can enhance corporate image and public acceptance of a company's operations.

Threats

Water supply and quality problems are likely to pose a direct threat to business, particularly those with operations in water stressed areas. In some areas of the world, deteriorating water supply is already constraining company growth and disrupting operations. Going forward, companies may need to adapt to:

- More stringent water quality regulations;
- An increasing public scrutiny on water-related activities;
- Increasing competition for limited supplies;
- Increased costs for investments in equipment and technology to conserve water;
- An increase in the price of water to reflect the costs associated with its collection, distribution and treatment.

An additional consideration for companies is the impact on ecosystems caused by the removal of water from natural water systems.

A growing number of companies are taking steps to address water related risks. However, companies are at differing stages of implementing water management strategies. Going forward, Newton believes this is going to be an increasingly important issue.

Katie Swanston Associate Director of Investment Management, SRI Officer

Appendix 1

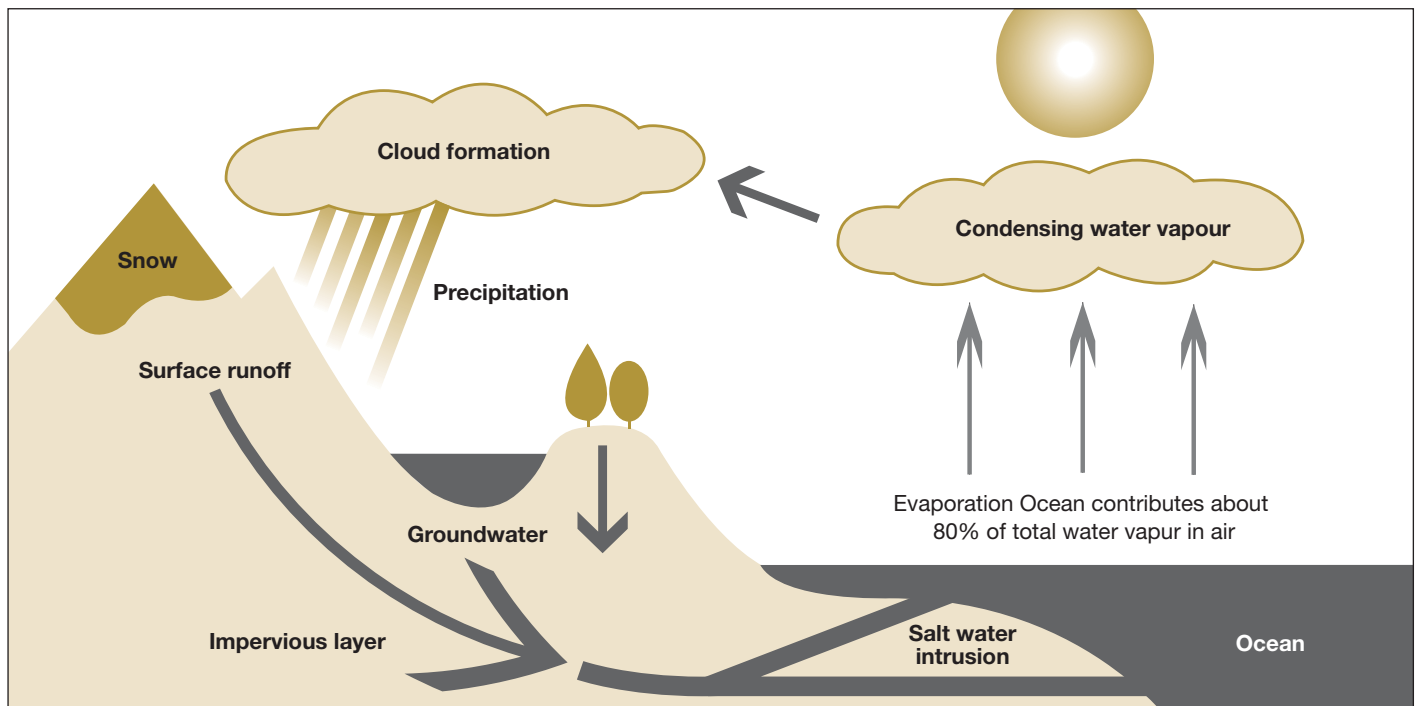
The Freshwater Cycle

The global water cycle can be described as a continuum of water movement, with no end and no beginning. No new water is being made and no water can escape from the Earth. The water we use is recycled over and over again.

Within the water cycle, solar energy evaporates water from the ocean, lakes and rivers. This evaporated water then rises into the atmosphere as water vapour. The water vapour is pushed over the land and up over mountains by winds. As the water vapour rises, it condenses into small airborne particles to form dew, fog, or clouds. Condensation occurs when the air cools or by increasing

the amount of vapour in the air to its saturation point. When this occurs, the droplets fall to earth in various forms of precipitation. Precipitation that reaches the surface of the earth occurs in different forms, including rain, snow, sleet and hail.

Precipitated water may be stored as ice or snow, potentially locked up in such a state for a long period of time. It may also fall into a waterbody or onto land where it is dispersed in several ways. For example, it may run into streams and rivers, penetrate into the soil or be intercepted by plants. Eventually, the water cycle will begin all over again.



Source: South Australia Water, Our Water Cycle (www.sawater.com.au)

Appendix 2

International Agreements And Multilateral Environmental Agreements (MEAs)

Source: United Nations Educational, Scientific and Cultural Organisation (UNESCO):
The 2nd UN World Water Development Report: 'Water, a shared responsibility', March 2006.

- **The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal**
Entered into force in May 1992. As of 28 May 2004, 159 states and the European Union were Parties to the Convention, which is an effective mechanism for addressing waste generation, movement, management and disposal. It plays a significant role in the safe management of chemicals. Recently, the Basel Convention joined with other existing international organizations in the creation of the Africa Stockpile Project, aimed at eliminating harmful stockpiles of pesticides on that continent. The Basel Convention is also working to create useful partnerships in areas as diverse as e-waste¹, biological and medical waste, and a global partnership aimed at addressing the stockpile of used oils in Africa.
- **The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade**
A voluntary procedure from 1980 onwards, and is now mandatory in the 73 countries that are party to the Convention. This Convention entered into force in February 2004. A total of 27 hazardous chemicals are currently subject to the PIC Procedure. To put this into perspective, about 70,000 chemicals are currently on the market, with 1,500 new ones being added each year. This poses a significant challenge to governments, which must monitor and manage the use of these chemicals. The treaty helps countries to reduce the risks associated with the manufacture, trade and use of hazardous chemicals.
- **The Stockholm Convention on Persistent Organic Pollutants (POPs)**
A global treaty, which entered into force in May 2004 and is designed to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms, and are toxic to humans and wildlife. They have been shown to cause cancer and to damage the nervous, reproductive and immune systems, as well as causing birth defects. At present, twelve hazardous chemicals, including DDT, dioxins and furans, are listed as POPs. In implementing the Convention, governments take measures to eliminate or reduce the release of POPs into the environment.
- **The European Union Water Framework Directive (WFD) on Integrated River Basin Management for Europe**
Adopted in October 2000, it coordinates the objectives of European water policy in order to protect all waters, including surface water and groundwater, using a river basin management approach. The WFD coordinates with all previous EU directives relating to water, including the Integrated Pollution Prevention and Control Directive (IPPC) of 1996, which addresses industrial installations with a high pollution potential. Such installations may only be operated if the operator holds a permit containing requirements for the protection of air, water and soil, waste minimization, accident prevention and, if necessary, site clean-up. These requirements must be based on the principle of Best Available Techniques (BAT) (see following section). The European Pollutant and Emissions Register, which has been compiled under the IPPC Directive, contains information on the emissions to air and water of nearly 10,000 industrial installations across Europe².
- **The UNECE Convention on the Protection and Use of Transboundary Waters and International Lakes (UNECE Water Convention)**
Intended to strengthen national measures for the protection and ecologically sound management of transboundary surface water and groundwater. It obliges Parties to prevent, control and reduce water pollution from point and non-point sources. More than 150 major rivers and 30 large lakes in the UNECE region run along or straddle the border between two or more countries. The Convention entered into force in October 1996 and has been ratified by 34 countries and by the European Community. It is open for accession by all UN Member States.
- **The 1992 UNECE Convention on the Transboundary Effects of Industrial Accidents**
Entered into force in April 2000, and 32 countries and the European Community are currently Parties to the Convention. This Convention cooperates with the UNECE Water Convention on issues related to the prevention of chemical accidents and the limitation of their impact on transboundary waters. In 2003 this resulted in the signing of the joint Protocol on Civil Liability and Compensation for Damage caused by Industrial Accidents on Transboundary Waters. The following work is being undertaken under both Conventions:
 - An inventory of existing safety guidelines and best practices for the prevention of accidental transboundary water pollution;
 - Safety guidelines and best practices for tailing dams, pipelines, and navigation of ships on rivers;
 - Alarm and notification systems;
 - International response exercises;
 - Transboundary contingency planning.

¹ E-waste is electronic and electrical waste including domestic computers and appliances

² The upgraded register, the European Pollutant Release and Transfer Register, should go online in 2009 and will then replace the present one, the European Pollutant and Emissions Register, EPER. Just like EPER, it will provide clear information about the level of specific pollutants, the quality of our local environment, emissions from specific industrial facilities and activities, and by country. But while EPER reports on 50 substances emitted to air and water, the PRTR will report on more than 90 substances released to air, water and land. The present register covers 56 industrial activities; the new one will cover 65. It will also have information on what the industrial installations do with their waste and wastewater. The reporting cycle will be annual instead of every three years. What is more, the PRTR will compile reporting of pollution from diffuse sources such as road traffic, aviation, shipping and agriculture.

Appendix 3

Best Environmental Practices

Source: United Nations Educational, Scientific and Cultural Organisation (UNESCO):
The 2nd UN World Water Development Report: 'Water, a shared responsibility', March 2006.

• Environmental Management Systems (EMS)

Aimed at achieving the organization's environmental policy, as defined by the top management. The system needs to describe various aspects, including setting responsibilities, defining environmental objectives, the means of achieving these, and the operational procedures, training needs, monitoring and communication systems that are to be used. The structure of an EMS is essentially an 'empty shell', within which the company defines its own unique ways of operating and establishing accountability. The most widely used EMS is that provided by the International Organization for Standardization within the ISO 14001 framework.

• Environmental audits

These should be carried out periodically in order to assess the effectiveness of the management system in place and its conformity with the organization's environmental policy and programme. Quantitative technical audits can form part of this process, such as water and energy audits. An environmental audit must also assess the organization's compliance with relevant environmental regulatory requirements.

• The European Union's Eco-Management and Audit Scheme (EMAS)

A voluntary scheme designed to promote continuous improvements of the environmental performance and compliance with all relevant regulatory requirements regarding the environment. To achieve this aim, industrial sites in Europe are required to use an environmental management system to monitor efficiency and to report on their achievements regarding environmental performance. They are also encouraged to seek ISO 14001 accreditation. EMAS statements are principally focused on improvements of environmental performance by describing the current environmental conditions and the operational aspects required at the site level to deliver continuous improvements in environmental performance. In regulatory instruments, permits set the emission limit values for the company's activities. The licence stipulates a maximum load on the environment and what reduction of this load must be achieved. The EMAS environmental management system is an instrument that provides industries with a set of appropriate means for achieving an effective reduction in the load on the environment.

• Best Available Technology (BAT)

The BAT concept is a useful standard-setting tool for emissions reduction in many industrial sectors. In the European Union (EU), however, the use of BAT is mandatory as part of the Integrated Pollution Prevention and Control (IPPC) Directive of 1996. Since 2000, all new industrial installations in the EU have been subject to the IPPC Directive and the BAT provisions. Imposing new and considerably tougher BAT rules on all existing industrial installations in the EU could jeopardize many European jobs, and therefore the IPPC Directive granted these installations an eleven-year transition period (i.e. to 2007). In many cases, BAT means quite radical environmental improvements, and sometimes it can be very costly for companies to adapt their existing plants to BAT. 'Best' is defined as that which is most effective in achieving a high general level of protection of the environment as a whole. 'Available' techniques are defined as those which can be implemented in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and benefits and whether or not the techniques are used or produced inside the country, as long as they are reasonably accessible to the operator. This includes both the technology used and the way in which the industrial installation is designed, built, maintained, operated and decommissioned. The following considerations should be taken into account when determining BAT:

- The use of low-waste technology;
- The use of less hazardous substances;
- The furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;
- Comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
- Technological advances and changes in scientific knowledge and understanding;
- The nature, effects and volume of the emissions concerned;
- The commissioning dates for new or existing installations;
- The length of time needed to introduce the best available technique;
- The consumption and nature of raw materials (including water) used in the process and their energy efficiency;
- The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
- The need to prevent accidents and to minimize the consequences for the environment;
- The use of information published by the EU or by international organizations.

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