The Challenge of Water

Written By: **Ron Dembo**
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THE CHALLENGE OF WATER

→ The enormity of the threat of global warming has rightly focused attention on its causes, primarily the burning of fossil fuels. But the more we look at climate change, the more we realize that it is a complex web of cause and effect. At the heart is the issue of the sustainability of life on the planet. And one of the essentials of life is, of course, is water.

Water is linked with the causes of climate change because of the energy required to collect, purify and distribute it. At the same time, our rivers, lakes and wells are among the first resources to show the stresses of global warming.

We depend on water not only to drink, but for our food production, the manufacture of our clothes and other goods, and almost every aspect of our lifestyle. Any impact on our water resources therefore affects many elements of our lives. This interconnectedness means we cannot address climate change without examining the role of water, and we cannot remedy the problems of our water supplies without tackling global warming.

The idea that water might be a problem can be hard to comprehend. Surely there is no shortage? We are surrounded by the stuff. Nearly three-quarters of the earth's surface is liquid. We have lakes, rivers and oceans full of it. Rain, sleet and snow constantly replenish them. But the plenitude of water is something of an illusion. As the sailors in The Rime of the Ancient Mariner discovered when they were becalmed at sea: “Water, water, everywhere, nor any drop to drink.”

Over 97 percent of the world's water is salty. Of the remainder, 70 percent is locked up in the polar ice caps, permanent snow cover and glaciers. That leaves less than 1 percent of the world's water that is fresh water, and even then not all of it is accessible. The Great Lakes in Canada, for example, which hold around 85 percent of North America's surface fresh water, drain to the north while the majority of the population is to the south. Also, the Great Lakes, which hold around 85 percent of North America’s fresh water they renew at a rate of less than 1 percent a year. Elsewhere in the world, pollution makes a significant proportion of fresh water undrinkable. Underground water supplies in 90 percent of Chinese cities are contaminated, while more than 70 percent of China's rivers and lakes are polluted, with scientists recently describing the Yangtze River as 'cancerous'.

GROWING DEMAND

→ Meanwhile, the demand is growing. The world's population of nearly 6.8 billion is increasing by 80 million people a year. Many of the world's drier and more densely populated areas are already showing signs of water stress, where the demand for water exceeds the supply or poor quality restricts available water use. The United Nations estimates that 500 million people are currently stressed for water. As things stand, the situation can only get worse.

The withdrawal of freshwater from natural sources is predicted to increase by 50 percent by 2025 in developing countries and by 18 percent in developed countries. By 2025, 48 countries with nearly 3 billion people are predicted to face water stress or scarcity. By 2050, this will increase to 54 countries and 4 billion people – 40 percent of the world's forecast population at that time. And it won't be just those countries we currently associate with drought, but parts of China, India and Southern Europe too.

Even countries famous for being wet and rainy, like Britain, are showing signs of water stress. In parts of the country, there is already less water available per person than in Spain or Morocco. In March 2009, the UK Environment Agency called for water meters to be installed in every British home to save water because it believes that summer river flows could fall by 50 to 80 percent by 2050, and that many aquifers are likely to slowly dry up.

Drawing water from underground reserves is one of the ways that the world copes with the current demand for freshwater. But these aquifers are either finite or slow to replenish. In many places such as North China, Mexico, Jordan, Yemen and India, they are already drawing on these reserves more quickly than they can refill. Even in the US, which has good surface water resources, groundwater reserves are being depleted 25 percent faster than they are being replenished, and even faster in some areas.

WATER FOOTPRINTS

→ Freshwater is distributed unevenly across the planet, and its consumption is equally uneven. Water consumption differs hugely between the developed and the developing world, and from country to country. It is not just the water we drink, but the water that gets used in producing our food and other goods and services that counts. Water footprint, the volume of water needed for the production of goods and services consumed, is usually measured in cubic meters, where 1 m3 equals 1000 liters.

The average water footprint for someone in the US is 2,500 cubic meters a year, or 2,500,000 liters This is twice the global average, and over three times greater than the per capita average for China (700m3). Seventy percent of freshwater is used in agriculture, and the major factor affecting water footprint size is the consumption of food and other agricultural products. When you look at the volumes of water consumed by various foods and clothing items it becomes a little easier to see how one individual can be responsible for the consumption of such huge amounts of water.

A glass of wine requires 120 liters of water to produce, a cup of coffee 140 liters, and a glass of orange juice 170 liters there are big differences in the water requirements of various food items. One kilogram of potatoes takes just 250 liters of water to produce, whereas 1kg of maize requires 900 liters of water and 1kg of rice 3,000 liters. But these figures pale in comparison with beef, which requires a total of 16,000 liters per kilogram.

And it is not just food and drink. An American wearing a T-shirt, jeans and a pair of leather shoes has consumed 20,000 liters of water just getting dressed. (A pair of jeans takes 10,000 liters of water to make, a T-shirt 2,000 liters and a pair of leather shoes 8000 liters) And when he gets into his car, that's another 375,000 liters – the volume it takes to produce an average-sized vehicle.

The water used in the production of food, goods and services is known as 'embedded' or 'virtual' water. Its ubiquity in the production of almost everything we consume means that "every time goods are bought and sold there is an exchange of virtual water", as IBM commented recently in a report on water. It also means that underlying global trade is a trade in virtual water.

Countries with a high level of agricultural imports, with all the embedded virtual water the products contain, tend to be net importers of water, and vice versa. Top of the net water import table is Brazil, followed by Mexico, Japan and China. The UK is the sixth, with only 38 percent of the water it consumes coming from its own resources. The top water exporters of water are the US, Australia and Argentina.

OIL AND WATER

→ We all know that water is necessary to grow food, and even to produce our clothing and other goods, even if we had little idea of the quantities involved. Less well known is water's relationship with energy. Water is not only used in the production of energy, but energy is essential for the collection, treatment and distribution of water.

The amount of energy used for water differs widely by region. The Californian Energy Commission estimates that almost 20 percent of California's electricity supply and over 30 percent of its natural gas are associated with water use. Due to the relationship between energy generation and carbon emissions, it turns out that water, or at least the way we handle and use it, is a major contributor to global warming. In the UK, energy required for the transport, heating and treatment of water generates over six percent of the country's carbon footprint, greater than the footprint of aviation.

Such is the inter-dependency between water and energy that Peter Gleick, president of the environmental research centre Pacific Institute in California, says that in many areas where pumping and distributing water requires significant electricity use, reducing water consumption can bring bigger gains in terms of climate change mitigation than trying to reduce businesses and household energy use. This is borne out by a growing number of examples where companies taking steps to improve water efficiency have made significant energy efficiency gains at the same time.

REUSE AND RECYCLE

→ Dow Chemical's site in The Netherlands used to draw water from a local river for its industrial processes, purified it after use and discharged it into the sea. As part of an ongoing project to reduce its water waste, the company reconfigured operations to take in treated household wastewater from the local municipal supplier instead. Once Dow has used the water in its industrial processes, it is treated again and fed into the plant's cooling tower. As a result, three million tons of water per year that were previously used and discharged directly into the North Sea are now re-used a number of times. Not only is that an enormous saving of river water, but because the process of treating household water is less energy intensive than treating river water, the company is using 90 percent less energy on treating water than previously, and saving 1,850 tons of CO_2 emissions a year into the bargain.

A number of big water users, such as power generators, oil companies and brewers are discovering that water efficiency goes hand in hand with energy efficiency. It works the other way round too. When Sony set out to build new headquarters in Tokyo it stipulated that the design took into consideration the corporate goal of reducing CO_2 emissions by 7 percent by 2010 (from its baseline of year 2000 emissions). With this in mind, the architects chose an innovative heat pump system that captures waste heat from a local public sewage treatment plant and channels it into the building. The system not only saves around 3,500 tons of CO_2 per year, it has also resulted in a saving of 117,800m3 water used, which is 92 percent less than a conventional design for an office building of its size.

The link between water and energy is also well illustrated by one of our most bizarre modern-day products – bottled water. Not only does it take 3 liters of regular water to produce 1 liter of bottled water, the production and distribution also consumes enormous amounts of energy. Up to 50 million barrels of oil were required to produce the 33 billion liters of bottled water consumed in the US in

2007. Energy is used to make the plastic and turn it into bottles, to treat the water, to fill and cap and bottles and to transport them. Transport is the most variable factor, and depends on whether the water originates in a local spring or is filtered local tap water, or whether it is imported from France or Fiji. Taking transport into account, bottled water on average requires 2,000 times more energy to produce than tap water. We are paying a gigantic energy premium for the 200 billion liters of bottled water the world drinks a year in total, especially since most of it is drunk in countries where the tap water is good.

WATER, ENERGY, CLIMATE

→ "In an increasing spiral, demand for more energy will drive demand for more water; demand for more water will drive demand for more energy," says the World Business Council for Sustainable Development in a report in 2009 on water, energy and climate change. The report describes how industrial, agricultural and domestic water and energy use can have damaging impacts on ecosystems, including loss of habitat, pollution and changes in biological processes, and how this in turn affects the amount of water or energy supplies available. "Climate change acts as an amplifier of the already intense competition over water and energy resources," says the report. And it concludes: "Water, energy and ecological footprints cannot be addressed in isolation."

The United Nations Third World Water Development Report of March 2009 comes to the same conclusion, while seeing an additional connection with financial markets. "Water is linked to the crises of climate change, energy and food supplies and prices, and troubled financial markets," says the report. "Unless their links with water are addressed and water crises around the world are resolved, these other crises may intensify and local water crises may worsen, converging into a global water crisis and leading to political insecurity at various levels."

A PERFECT STORM

→ We are facing a perfect storm of water, food and energy shortages, which could strike in less than 20 years, says Professor John Beddington, the UK's chief government scientist. He highlights the pressure on water sources as developing countries move from diets based on simple agricultural products to more complex foods and, in particular, more meat and dairy products. (We have already seen how water intensive the production of beef is, and it is much the same for pork, chicken and other livestock meats.)

The demand for food will increase by 50 percent by 2030, driving the demand for more water. When you factor in the impact of climate change – California, for example, will not be able to produce agricultural products within 25 years, predicts Nobel prize-winning physicist and US Energy Secretary Steven Chu – it raises the question of what can we possibly do to avert this crisis?

Well, we could boil the sea. Already, Bahrain relies entirely on desalination for its water, while Saudi Arabia, Kuwait and the United Arab Emirates are also heavily dependent on the technology. Even London is looking to this solution, and is currently constructing a desalination plant to meet future emergency water needs, with more proposed for other British coastal cities.

But desalination is expensive and impractical for many water-short countries, and is obviously not available to those that are land-locked. Desalination is also a classic case of water and energy interdependence. Most existing plants rely on energy from traditional sources, with their associated heavy carbon emissions. The city of Perth in Australia has avoided this problem by finding a renewable solution. The city's desalination plant is one of the biggest in the world, producing 140,000 m3 of drinking water a day, enough for the whole area. The electricity needed for the process is entirely produced by 35 windmills located 260 km from the plant. But this is the exception.

Desalination has other environmental impacts. Its by-product is warm concentrated brine, which can contain chemicals used in the water processing that are harmful to marine life, and which is heavier than sea water so tends to sink without mixing when discharged.

MAKING THE INVISIBLE VISIBLE

→ The Perth water plant driven by wind turbines at least makes the connection between water and energy clear. This is one of the first steps in dealing with the issue of water – making the invisible visible. We have to make the virtual water embedded in all our goods and services visible. We know it is there in agricultural production, although few of us have realized the scale of water involved in coffee, beef, jeans and shoes. We need to account for it elsewhere too.

It is the same situation that we are in with carbon. The first step in controlling and reducing carbon emissions is knowing where they take place. Either because they realize the value of reducing their emissions (in energy cost savings, ensuring a sustainable future, etc.), or under pressure from government, investors or other stakeholders, many organizations are now trying to identify all the areas where they produce carbon in the full lifecycle of the goods or services they create. Once identified, the emissions can be measured, and once measured they can be managed. We now have a growing number of tools to measure and manage carbon across organizations, large and small. We need to do the same with water.

Another parallel between water and carbon is price. It is taking time to establish a universal price for carbon but we are getting there with cap-and-trade schemes and taxes. Although households and businesses generally pay for water, it is usually cheap and in many places it is free. Such is the discrepancy between the essential nature of water and its price that economists use the comparison between cost of water and diamonds as the classic example of what they call 'the paradox of value', where things that have the greatest value in use often have little value in the market. This is not to say that peasant farmers in developing countries should be made to pay to irrigate their crops, but that there needs to be some kind of pricing system for water that recognizes its value and encourages a change in attitude towards its use. When IBM discussed the issue of water with a number of leading experts for its 2009 Global Innovation Outlook report, they said that "without an accurate and fair pricing model to provide a monetary incentive for infrastructure build and efficiency of use, the issues of wastefulness, pollution and scarcity would never be mitigated."

While we recognize the similarities between carbon and water, we also need to recognize their differences. Our problems with carbon arise because we are emitting far more than can be reabsorbed by our natural ecosystems. This excess carbon stays in the atmosphere creating the greenhouse effect that leads to global warming. Water, on the other hand, is about flows. We are consuming, redirecting or altering the state of water faster than it can replenish itself. Our remedies for the problems of water need to recognize and restore its natural flows.

We also need to seize the opportunities of water. There is now a thriving business in carbon measurement and mitigation, renewable energy and other clean technologies. We need to create the same impetus for water. We've already seen the benefits that can flow from the smarter use of water at places like Dow's Dutch chemical plant and Sony's new headquarters. Often, the challenge is one of optimization, and we have much experience and many skills and tools, such as sensors, computers and mathematics, that we can bring to bear on these problems. This is beginning to happen.

General Electric and the National University of Singapore are investing $100 million into researching water problems and solutions. Singapore, which has few water resources of its own and imports much of its needs from Malaysia, has embarked on a major effort to use technology to achieve water self-sufficiency. Meanwhile, IBM has a major research and development program under way called Smart Water Information Management that is looking at applying sophisticated technology to water management, including smart sensors, computer modeling, analytics and visualization tools.

Zerofootprint has released a software product for measuring the water footprint of a large institution and has coupled it with the measurement of carbon footprint. Since water embodies energy (the energy used to pump it, clean it, desalinate it, etc.), and energy embodies water (power generators are big users of water for example), it could be said that water is carbon and carbon is water. There is also a trade-off between carbon and water since carbon is often required to process water for recycling. All in all, managing an environmental footprint is a complex decision making process for large corporations that requires sophisticated software. Focusing on minimizing carbon alone might lead a corporation to do poorly on its water footprint.

Water presents business with a challenge as well as opportunities, and it should become part of every organization's corporate social responsibility (CSR) program, says Mike Gambrel, executive vice president, Dow Chemical. "Together, we need to take an integrated approach that goes beyond just technology but includes water usage, management, delivery, infrastructure, finance, and education – the entire supply and delivery chain. And businesses must have the will to create technology solutions that make money, while including clean water in their CSR programs," he says.

CONCLUSION

→ Water is an integral part of life on Earth. It is integral to our environment, climate, agriculture, energy generation, manufacture and almost every aspect of our lifestyles. It is also an integral part of the crisis facing the planet. We must treat water with the same sense of urgency that we have for global warming. Indeed, it must become an integral part of our climate change solutions.

ABOUT ZEROFOOTPRINT

→ Zerofootprint is a socially responsible enterprise whose mission is to apply technology, design and risk management to the massive reduction of our environmental footprint. We operate both in the for-profit and charitable domains through two entities, Zerofootprint Software and Zerofootprint Foundation using shared technology.