Dutch Masters

Leading the renaissance in water technology

If oil has dominated the global geopolitical agenda for most of the last 50 years, then the next half-century is likely to belong to water. A combination of climate change, water table pollution, population growth, and the long-term effects of mass urbanization are increasing the scarcity value and undermining the quality of this most vital of natural resources with potentially devastating consequences.

Consider these statistics from the World Water Council (WWC). An estimated 1.1 billion people already live without clean drinking water; 2.6 billion people lack adequate sanitation; 1.8 million people die every year from diarrheal diseases; and 3,900 children die each day from water-borne disease. But water scarcity is not merely a health issue. The WWC has also identified some 260 river basins that are shared by two or more countries between which there are generally inadequate legal or institutional arrangements to settle disputes over issues of water redistribution (through dam construction, for example) or when acute shortages arise. Like oil before it, water could well become a cause of war. Blue, in other words, is rapidly emerging as the new black.

It is hard to escape the conclusion that mankind is in danger of sleepwalking into a largely avoidable catastrophe as there is, in theory, plenty of usable water in circulation

Photo: Adam Gault/Photodisc/Getty Images

on earth to sustain its 6.5 billion inhabitants – around 40 million cubic kilometers (km^3) in fact. Given that those 6.5 billion earth dwellers only need an estimated 8,000 of that 40 million km^3 each year, there should be plenty to go round.

It is, of course, not as simple as that. Estimates vary, but human drinking, cooking, bathing, and sanitation needs account for between 5 and 10% of all water consumption, industry needs a further 10-20%, and agriculture accounts for the rest –

> **"There's certainly enough water for every person on the planet."**

between 70 and 85%. This means that there is an overwhelming demand for water in countries whose economies are predominantly agricultural, which explains why it is the world's subsistence farmers who are so susceptible to drought. "There's certainly enough water for every person on the planet," Marq de Villiers observed in his 2001 book *Water Wars*, "but too often it's in the wrong places at the wrong times in the wrong amounts."

And, he might have added, of the wrong quality, for as the WWC's statistics suggest, water tables are increasingly being polluted by industrial, medical, and human waste to the point that conventional water sources pose a serious risk to human health. But while tackling global issues of water redistribution may be too daunting a task for any one country or industrial sector to address by itself, improving the quality of the water that is available is most certainly not. The Dutch public and private sectors, along with Dutch central government and local authorities, are currently demonstrating this with a striking display of determination and cooperation.

Photo: KWR

In the days and weeks that followed the earthquake in Haiti this January, most of the media attention understandably focused on the frantic attempts to find survivors and on the plight of the country's homeless survivors. Behind the scenes there was also a gargantuan international campaign to bring some immediate relief to those survivors, many of whom were sleeping out on the streets and had gone days without food or water. While most television channels carried footage of frantic Haitians scrambling for the bottled water being distributed from charity trucks, a much less photogenic but equally important source of water was quietly being established by the Dutch company Norit NV, who provided seven advanced Perfector-E compact water treatment systems capable of providing 336,000 liters of reliable drinking water each day.

Norit and its partner PWN developed the Perfector-E in the wake of the 2004 Asian tsunami to address the immediate demand for drinking water that such natural disasters create. However, this is only a small – if invaluable – indication of the depth of its technological expertise in the field of water processing technology in which the company, and the Dutch water sector as a whole, excels. Founded over a century ago, Norit and its subsidiaries are now international market leaders in the fields of – among other things – desalination, potable water, and the processing of municipal waste water, much of it based on innovative membrane technology. In the past 12 months it has won two significant contracts – one for the design, procurement, and installation of China's single largest water reuse project in Beijing, and another for the world's largest ultrafiltration (UF)-based waste water reuse project in the Qatari capital of Doha.

Both projects will benefit from Norit's experience in Namibia's capital of Windhoek which, according to Norit's Chief Growth Officer and Board Director Menno Holterman, is the first location in the world where the water loop is closed and waste water is treated and recycled into the manufacturing process as well as for drinking water. "All the waste water is collected and treated within six days and is piped back into the city, where it is reconsumed as potable water," he explains. "They've even built a brewery

on the way back into town which uses the treated effluence as raw water to brew the beer."

Paques is another Dutch water-processing company with a significant presence on the international stage, a commitment to sustainability, and recent success in China. Paques's specialty is biotechnical solutions, including the proprietary BIOPAQ© technology that works by enabling anaerobic bacteria to convert the organic pollutant present in industrial and municipal waste water into biogas that can then be used as green energy. By investing heavily in research and innovation over a period of decades, it has consistently managed to develop a broad range of sustainable and successful technologies such as the Shell-Paques process. Based on the company's THIOPAQ© technology for the desulphurization of biogas, Paques joined forces with Royal Dutch Shell to adapt THIOPAQ© for use in the treatment of natural gas and gas streams from the (petro) chemical industry. There are now more than 100 reference plants based on this technology in operation worldwide.

"Our clients come from both public and private sectors," says Paques's Managing Director Rob Heim, "and we give them added value in the form of bio energy generation, the reuse of water, and the reclamation of resources. This allows them to combine economic progress and environmental responsibility." There are now more than 750 BIOPAQ© plants operational worldwide that between them produce enough biogas to cover the yearly natural gas consumption of nearly 1.4 million households in the Netherlands. As an added bonus, they are also responsible for an annual reduction of 5.5 megatons in CO_2 emissions. There are more plants on the way, including at a paper mill in Tianjin, China, where Paques's sister company, Paques Environmental Technology Shanghai, was recently awarded a contract by the Chinese paper giant Nine Dragons.

It is no coincidence that the Netherlands should enjoy such a commanding presence in the international water processing market or that Dutch companies should embrace such a diversified approach to problems of waste water management. Water has been a national preoccupation – some would say obsession – for centuries.

As Peter Glas, Chairman of Unie van Waterschappen, or UvW (Dutch Association of Regional Water Authorities), is fond of pointing out,

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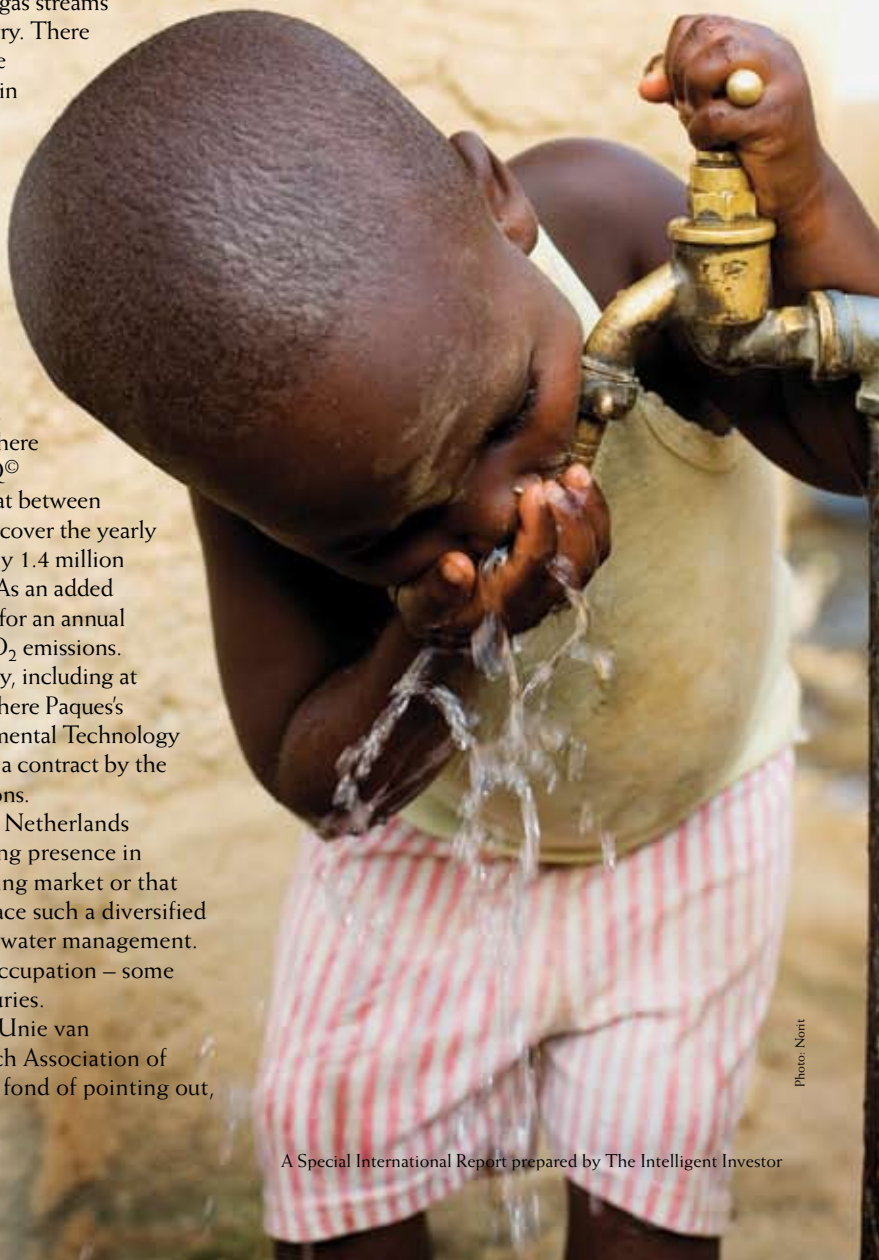
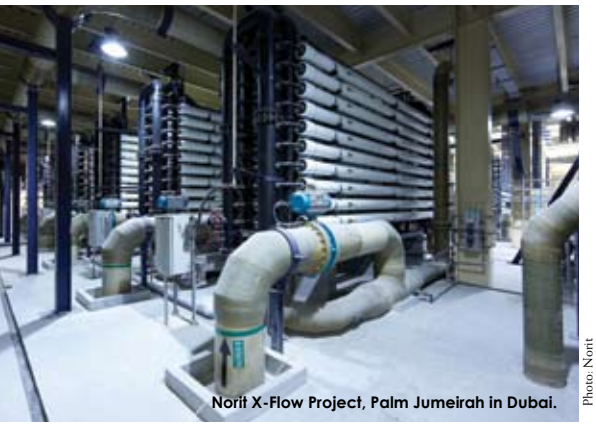


Photo: Norit

Norit provides every-day clean water for over 9% of the world's population.

Photo: Norit



Norit X-Flow Project, Palm Jumeirah in Dubai.

Photo: Norit

his country's directorate for public works and water actually predates the establishment of the Dutch monarchy by 15 years. Such is the importance of water to the Netherlands. Though his illusions of grandeur stop there – he also wryly observes that his member organization's main function is to keep the pumps working 24/7 and Dutch feet dry – he is making an important point; that for centuries, flooding has consistently posed a devastating threat to his country's economy.

It continues to do so and the UvW remains vigilant. In the 1990s the Rhine and Meuse rivers both burst their banks, prompting increased investment in the Delta (flood protection) Plan and the formulation of a flood protection plan by the newly appointed Delta Commission.

Glas believes that the world has a lot to learn from his country's administrative approach to its water issues, as well as from the technology it has developed to manage the problem. "You need both water management and safety management," he says. "Innovation isn't just about technology – there has to be an integrated approach which also deals with things like physical planning, emergency evacuation, and the systems that make people more self-reliant in an emergency. Because we live in a delta with a constant threat of floods, the Netherlands government has a special body for water management that also collects taxes. Those first Regional Water Authorities were established nearly 800 years ago."

There is an old Dutch saying that "God created the world, but the Netherlands were created by the Dutch," and the country's continuous struggle to reclaim land from its rivers and the sea are the stuff of legend. What is less well known outside its borders is the importance of water purification in this struggle, or how this has shaped the very fabric of the country's economic and industrial base.

"Because we are situated in the Rhine Delta and a lot of dirty water flows though our country every year, we have been concerned with water purification as well as land reclamation for a very long time," explains Eric Vos, secretary of the Frisian Water Alliance. "Matters have been made worse because we are a very heavily populated country, and our industries have used the river as a means of disposing of their waste water." The situation is exacerbated by the fact that since so much of the Netherlands is below sea level, a growing part of its water table is naturally salinated to an unacceptable degree.

As a result, the Netherlands were obliged to become the first country in the world to introduce a tax for waste water. This provided the farmers and the food processing industry that formed the backbone of Friesland's economy with a choice – either pay the tax or purify their waters in their own industrial processors. They elected to turn to their plant and machine suppliers for help in solving their problems, and many of the companies now at the cutting edge of water processing technology were consequently spawned by the suppliers to the Dutch food processing industry.

Since then, the sector has built up an impressive array of knowledge; its expertise has been pooled and new applications are being constantly developed

"The Netherlands were the first country in the world to introduce a tax for waste water."

by a number of research institutes that are supported by public organizations (including the UvW) and the private sector alike.

KWR is one such research institute, established after World War II as a receptacle in which the knowledge and technical expertise accumulated by 200-odd water utility companies could be brought together, shared, and developed. For many years its remit was confined to drinking water, but two years ago it made a decision to diversify into the entire water-use cycle.

"Our core business is applied research and the application of knowledge," explains KWR's CEO, Wim Van Vierssen. "A lot of what we do is dedicated to improving existing operations – and that in turn entails making improvements to existing technologies and helping to introduce

"Water has been a Dutch preoccupation – some would say obsession – for centuries."

breakthrough ones." KWR develops and enhances water technologies in close cooperation with their end users, who range from the Dutch water boards to companies operating in both the water and a variety of other industrial sectors. Recent projects have included studies into the possible use of digital GIS technology to analyze water distribution networks, and into the recovery of energy, nutrients, and water from a sugar factory for supply to local greenhouses. KWR owns the proprietary technology for, and is a key player in, the field of desalination of brackish or sea water.

As the focus of this second project would suggest, KWR's client base has expanded along with its areas of expertise, says Jos Boere, head of the institute's Water Technology Group. "These days we are increasingly involved in research programs that are funded by companies working in sectors ranging from petrochemicals to textiles."

One of KWR's sponsors is Vewin, the umbrella organization for the country's ten water companies that acts as both the industry's lobbying body on the domestic and international stages, and as a central point of contact between its members and other industrial sectors in the Netherlands. Its CEO, Theo Schmitz, also believes that water management cannot be tackled in isolation. "In many respects, the interests of water companies reflect those of many other organizations, which is why Vewin constantly seeks to collaborate with consumer conservation and environmental organizations."

In its capacity as international ambassador, one of Vewin's priorities is to ensure that its members play their part in helping reach Target 10 of the UN Millennium Development Goals, namely to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015. If successful, this initiative will have a beneficial effect on over one billion of the poorest people on earth.

"Holland is playing an important part in making this happen," says Schmitz. "We are already active in more than 30 countries in what has been called capacity building, and we are the pioneer in the use of ultra-violet (UV) techniques for the disinfection of water."

Among the organizations using this pioneering technology is an arm of Philips, one of the country's most well-known companies. "While access to safe drinking water is arguably the most pressing issue in the developing world, here in the developed world we've got used to what can only be termed as the most unsustainable means of accessing it – bottled water," explains Sridhar Kumaraswamy, VP of Water & Air at Philips Consumer Lifestyle. "There is a big difference between 'safe' and 'sustainable' water supplies."

Philips has consequently decided to focus on improving water quality as it comes out at what the industry calls 'point of use' – and most consumers call the faucet. Its first internally developed UV water purifier was specifically designed for the Indian consumer market, and it won a UNESCO-approved award. A pilot scheme has also been launched in Brazil. But developing a product for universal application will not be easy as consumer behavior and attitudes to water consumption vary from place to place as much as the quality of the water itself.

"From a technological perspective, the challenges are immense," says Jean Bart Bleeker, Kumaraswamy's colleague and Director of the Water & Air Innovations team. "The sheer fact that impurities in water can vary extensively and that we consequently

Photo: Paques

There are over 750 plants using Paques BIOPAQ© technology in operation globally.

Photo: Vewin

Holland is the pioneer of UV light water purification technology.

need different technologies to address these different purification requirements makes the task of creating a standard technology platform daunting."

But so, it must be said, would be the rewards for getting it right. It would be misleading to suggest that Dutch commitment at either national or company level to improving the world's water is entirely altruistic; the concerted drive that the Netherlands embarked on some ten years ago to develop and promote a new generation of water technology firms was borne as much out of expediency as of charitable intentions.

A combination of the country's proud track record in all aspects of water management, and the looming global crisis, made water processing technology development a logical candidate for investment – a decision fully supported by the country's Ministry of Economic Affairs who describes water technology as "one of our key interests." A decision was taken to establish a national innovation program on water technology (in which all the organizations and companies mentioned above – as well as many others – cooperate). To develop the pre-competitive research element of the program, a Technological Top Institute (TTI) dedicated to water technology was initiated, and in 2004, Crown Prince Willem-Alexander (himself a professional water management specialist) opened the Wetsus Center of Excellence for Sustainable Water Technology in Friesland Province's capital of Leeuwarden. Over 80 companies and 13 universities from all over Europe are currently involved with Wetsus in one way or another.

The TTI concept is part of a wider national strategy to create hubs of excellence, innovation, and commerce around specific industrial sectors that seem destined to flourish in tomorrow's global environment.

In many ways they are microcosms of a deeper Dutch philosophy to encourage genuine partnerships between government (who contribute 50% of the funding), the universities (25%), and industry (25%).

It is a win-win formula for all parties. Through its involvement the government gets to stimulate economic growth; the universities both strengthen their ties with industry and participate in hybrid academic centers, which can only increase their prestige and attract talent in the form of both students and teachers; and industry not only defines the research program but also has first right of refusal over any promising ideas and patents that come out of the laboratories.

The multi-disciplined research primarily takes place in the Wetsus laboratories in Leeuwarden and is carried out by PhD students from the 13 participating universities. The students can also study for an MSc in Water Technology that Wetsus has designed and teaches in collaboration with the universities of Wageningen, Twente, and Groningen. The researchers at Wetsus are

Wetsus lab work in progress.

Photos: Wetsus

brimming with ideas, according to its co-founder and Scientific Director Cees Buisman, who believes that with the right multi-disciplinary approach it will be possible to solve many of the world's water resource issues. He is currently particularly excited about the progress being made in two specific fields of research – 'blue energy' and 'black water'.

The official technical term for 'blue energy' is reverse electrodialysis, and it derives power from the process of mixing two solutions of differing salt concentrations by passing them through an ion-exchange membrane stack. In the blue energy model, the two solutions in question are salt and fresh water, and the resultant energy is used for the economic generation of electricity, but without the production of CO_2, NO_x, or any other pollutants. "When we started working on this everybody kept asking us, 'If this is such a good idea, why hasn't anybody done it before?'," Buisman recalls. "Now, lots of other people have begun looking at this – they were just waiting for somebody else to start."

"Blue energy power plants can be situated wherever salt water and fresh water meet."

One of its main attractions is that blue energy power plants can be situated wherever salt water and fresh water meet, or wherever rivers flow into the sea, which means it has as much potential in the Hook of Holland as it does, say, in the Mekong Delta. But there is another reason why the technology is eliciting so much interest, and that is an economic one. Given the difference in the salt concentration between the rivers and sea in his native country, Buisman believes the Netherlands could generate 3,500 megawatts from blue energy – or 30% of its entire electricity production – for a considerably smaller sum than the UK is currently investing in wind energy.

While the blue energy project is still some way from being fit for purpose, the black water initiative is already in 'beta test' mode. About 30 kilometers south of Leeuwarden, in the town of Sneek, 32 apartments have been fitted with an experimental method of household waste water collection in which the black (toilet) water is kept separately from grey (remaining) waste water. The black water is collected via a vacuum toilet (similar to the system used in airplanes), which reduces the volume of water as only a minimal flush is required. As a result, says Buisman, the houses are using 50% less drinking water than was previously the case. Energy and raw materials such as phosphor can also be recovered from the black water and medical residues safely destroyed before discharge. The 'grey water' can be reused for irrigation and various other purposes after relatively simple treatment.

The Sneek initiative is significant not just for the technology but for the very fact that the authorities have facilitated a pilot scheme on such a scale. It is symptomatic of the enlightened approach to the Wetsus initiative that the authorities in Friesland have adopted. This, says John Jorritsma, the Queen's Commissioner in the province, is based on the

The Science Center Johannes de Doper, a deconsecrated church in Leeuwarden, is home to a water campus and the ground-breaking research at Wetsus' laboratories.

Cees Buisman, Wetsus' Scientific Director, briefs the European Commission.

principles of technology, talent, and tolerance. As well as being instrumental in helping Wetsus obtain the funding to develop the technology, the province has also now developed an educational roadmap from primary school to PhD level, to provide courses specifically relating to water technology at every stage of a child's development.

But perhaps most unusual is the tolerance aspect of the strategy, for Friesland has not just relaxed its planning regulations to make pilot schemes such as the Sneek black water trial possible; it is also facilitating the construction of laboratories and demo sites with dedicated facilities that startup companies, without the capital to build their own, can rent as and when required. The Queen's Commissioner was fully supported in this by the Chamber of Commerce for Northern Netherlands, which was heavily involved in the creation of Wetsus with the bigger picture in mind. "This is not just about creating a knowledge base," explains Evert Wind, Director of Regional Development. "It is also about creating a business environment; the whole project is intended to create spin-offs for the economy as a whole."

"The Netherlands and Leeuwarden are well on track to become the water sector's very own Silicon Valley."

Leeuwarden's mayor, Ferd Crone, strongly supports the establishment of the institute, which is in harmony with his stated aim of getting Leeuwarden recognized as the 'European Capital for Water Technology.' A water campus of some three hectares is being developed to this end and a deconsecrated church has been converted into a small business center for the growing number of startup and spin-off companies gravitating to the town. Alderman Henk Deinum recently announced the go-ahead for the development of approximately 25,000 square meters of offices and laboratories on the campus as the next step in this grand plan. And to stimulate 'water entrepreneurship' there is a series of annual initiatives that include the Wetsus Rabobank Water Business Challenge and master class organized in conjunction with Aquatech Global Events. The program is designed to facilitate in-depth discussions on recent dedicated case studies, and offer opportunities for interaction and networking between the decision makers in the industry.

There is an unmistakable buzz of creativity around Wetsus, the church, and in the town in general, and Leeuwarden is gradually acquiring the critical mass it requires to attain the international status it seeks. There is more to come. Wetsus is in the process of establishing a global dedicated Water Technology Investment Fund with a target size of €50-€100 million, and next year will also launch an Executive MBA for the Water Technology Sector in conjunction with the Rotterdam School of Management. If blue is the new black, the Netherlands are leading the way, and Leeuwarden is well on track to become the water sector's very own Silicon Valley.