Creative solutions are needed to protect planet Earth's most precious commodity. ***Mary Sweetman surveys*** *the challenges, the opportunities and some novel Irish technologies bubbling to the surface.*

THE BLUE CHALLENGE

We live on a blue planet. Water covers approximately 70 per cent of our world's surface. Yet only 2.5 per cent of this is fresh water, suitable for drinking. And of that 2.5 per cent, less than 1 per cent resides in lakes and rivers, while more than two-thirds is locked away in glaciers. So in an increasingly water-thirsty world, much of the population relies on that remaining 30 per cent in the form of groundwater for consumption and growing food. It's hardly surprising that the planet's millennia-old aquifers are being drained more quickly than nature can replenish them, and the concept of 'peak water' is a real prospect. According to the UN Environmental Programme (UNEP), by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water-stressed conditions.

And that's not all. The problems of water are myriad. "It's urbanisation, it's the ageing infrastructure, water scarcity and rising energy costs," says Paul O'Callaghan, founder of the water market intelligence company O2 Environmental. "Historically, legislation has been about protecting the environment, protecting public health and providing safe drinking water. These are still the core drivers, but people are having to look at new ways to achieve those aims. For example, in Sydney, Australia, they mine sewers for water. A company has made a business out of extracting it, treating it and selling it back as irrigation water for games fields." Likewise, in countries that can afford the astronomical energy input required, like oil-rich Saudi, major sea-water desalination projects are under way.

WATER QUALITY Water availability is one thing; quality is another. Globally, the UNEP says the most prevalent water quality issue is eutrophication – a result of high-nutrient loads (mainly phosphorus and nitrogen) from agricultural runoff and domestic sewage entering water systems where they feed the rapid growth of algae, starving other aquatic life of vital oxygen. In the UK, the cost of water pollution from agriculture is estimated at around €345 million annually.

> The Cork company's technology has been recognised with several international awards and will be featured on a Discovery channel documentary later this year.

Yet human sewage is a greater worry, given emerging concerns about the impact of personal-care products such as birth control pills, painkillers and antibiotics on the ecosystem. Biosolids keep being generated every day, so local authorities need to dispose of them, and at present, the leading option is spreading on land.

"It is simply not sustainable to continue to dispose of sewage sludge onto agricultural lands," says John O'Regan of the Cork water technology company SCFI. "We know for certain that we can find viruses, pathogens, antibiotics and hormones [on such land], because we medicate ourselves, and we use contraceptives, and all of that ends up in the sewage works." Inevitably there will be consequences, he argues. As a society, when we previously turned a blind eye to dumping our waste back into the food chain, the BSE crisis resulted.

CORK COMPANY CRACKS THE CHALLENGE

O'Regan is by no means a neutral observer. His company is ready to bring its patented AquaCritox process to the market. The process uses water at high temperature and pressure to destroy toxic and hazardous wet organic waste such as sewage sludge and chemical/pharma wastes. One of SCFI's partners, Parsons, the worldwide engineering consultancy (turnover $2.9bn; present in 25 markets) has described AquaCritox as a "ground breaking solution to one of the most important problems of our time," and has agreed to market the process to its global client base.

"It's a unique technology that is capable of completely destroying the organic fraction of sewage sludge," O'Regan says. "It's a straightforward oxidation reaction that proceeds very rapidly, in less than 60 seconds, and converts the sludge to carbon dioxide and water, so what we generate is harmless. The carbon dioxide can be reused in applications like the drinks industry or for dry ice production. We achieve a 98 per cent reduction in volume, and the residue is predominantly silica, which is suitable for use as a construction material."

Soaring fuel prices are a serious worry for those tackling waste streams that contain large volumes of water and low-grade energy – such as sewage sludge. So what's significant about AquaCritox is that the oxidation reaction is exothermic (i.e. it releases energy). That means the process is actually energy negative: recovered steam can be used for district heating or to produce electricity. The technology has been recognised with several international awards and will be featured on a Discovery channel documentary later this year.

Currently at the demonstration stage in Ringaskiddy, Co Cork, and through work with Northern Ireland Water, AquaCritox has been used in military but not yet in full-scale commercial applications. But says O'Regan, "We are projecting sales to start happening towards the end of this year. We have had interest from as far away as Australia and as locally as the UK. We are confident that our stars are aligning because of increased urbanisation and tightening environmental regulations."

VENTURE CAPITAL SET TO POUR IN With the commercialisation of technologies like AquaCritox, O2 Environmental's Paul O'Callaghan believes we could be on the cusp of a blue revolution. "Internationally, there has been an unprecedented amount of research and development in the area, and you are seeing some really innovative solutions starting to appear," he told *Technology Ireland*.

"We've seen venture capital rush into the IT industry; then there was life sciences and biotech, then clean tech. Even as late as two or three years ago, only 2 per cent of the total cleantech investment went into water. The VC community finds it a difficult space to understand and navigate. But there has not been that much activity in solar or biofuels, so they are looking for somewhere to put their cleantech dollars, and they will tell you that they really do like the idea of water because the long-term prospects are very positive.

O2 Environmental provides water industry market intelligence for three main types of clients: the venture capital community; start-ups that have come up with a solution they are trying to get to market, and the much larger water companies like Veolia, Siemens and GE Water, which are keen to look at acquisition and R&D opportunities.

"I started-up the company in Vancouver about five years ago," says O'Callaghan, a graduate of UCC, "and when I relocated back to Ireland, I was able to continue to serve an international client-base. We were asked to write a report for Global Water Intelligence on The World Water Technologies Markets 2010. That raised our profile internationally, and on the back of that, we have developed the BlueTech Tracker [a web based market intelligence resource] and we have evolved from being a consultancy into a more productised service provider. We've gone live with phase one of the tracker, and we will be going live with phase 2 on May 1, or possibly earlier."

OBSTACLES FOR IRISH INNOVATORS Back in Ireland, the other hat O' Callaghan wears is co-ordinator of W3 - the Water and Waste Water Treatment Industry Group – eight indigenous companies that have come together across a broad cross-section of the business, from sewage treatment solutions to rainwater harvesting, leachate treatment, interceptors, sampling and on-line and off-line analysis. It includes Irish leaders in the area such as Bord na Móna Environmental, which has developed innovative ways of treating waste, based on adsorption materials produced from peat and sea shells.

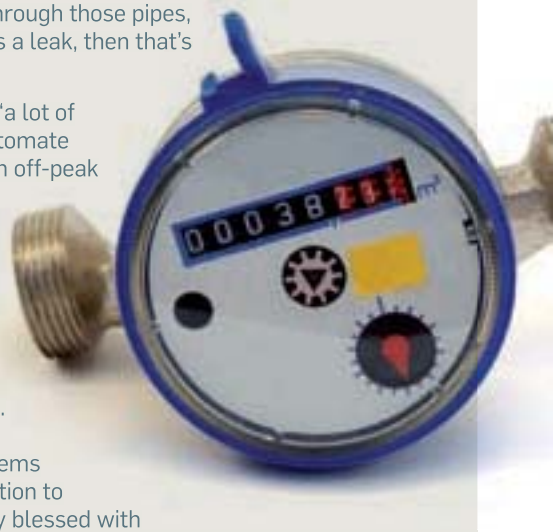
> "Ireland is strong in ICT, which has applications in automated metering, remote telemetry and radio communication devices."

WET, WET, WET
UNIQUE IRISH OPPORTUNITIES TO INNOVATE

The Irish market is small, and the most attractive opportunities for innovation in water technology are undoubtedly global. Nevertheless, W3 co-ordinator Paul O'Callaghan acknowledges that this country has some unique issues like cryptosporidium, and there could be potential to roll-out novel solutions here.

Moreover, Ireland has committed to invest some €400m pa in water infrastructure over the next number of years, which is significant in a small country, EI's Paul Butler points out. And there is the thorny issue of household water metering – not exclusively a Green Party concept. In fact, under the European Water Framework directive, all member states will be required to charge for water.

"If water metering goes ahead, there will obviously be opportunities for contractors to install the meters," O'Callaghan agrees. But the higher value benefit could be the stimulus it provides to develop new technologies. "Ireland is strong in ICT, which has applications in automated metering, remote telemetry and radio communication devices. Most of the water infrastructure is in pipes, and most of the energy required is in moving it through those pipes, so if don't know where or when there is a leak, then that's a lot of wasted energy.



"Aside from detecting leaks," he adds, "a lot of new software is looking at how you automate pumping schedules to play around with off-peak electricity rates, and how you cut down the pressure to just what you need. With the BlueTech Tracker, we see a lot of people getting into the smart water space, applying some intelligence to managing water."

There is yet another opportunity so close to us that it is almost overlooked. All of those who spoke to Technology Ireland noted that despite some problems with septic tanks and biosolids application to land, as a country we are extraordinary blessed with good quality water – a small payback for averages of up to 225 wet days every year. But this is something we don't sufficiently recognise as the asset it is – for food, drink, pharmaceutical and hi-tech industries. "In the US, Wisconsin is encouraging business to locate to Milwaukee because of the 'water advantage', O'Callaghan says. "I see places in the world now that are now promoting their water assets as a reason to invest there."

> Water regulators like the EPA would be keen to adopt real-time, smart enforcement monitoring.

W3 was founded in 2008, and as a starting point, the group identified the need to create a roadmap for the industry, looking at opportunities, strengths and key strategic research areas within 14 Irish institutes.

"It was incredible when we did a survey to find out how much was happening in each of the different third level research institutes," says O'Callaghan. "It's happening already, but not necessarily getting out to the market. We would obviously like the industry to embrace the opportunities, but they need to see that the conditions are right."

Helping to create those conditions, an Irish water and wastewater innovation centre is to be established under Enterprise Ireland's Competence Centre initiative. Competence centres are collaborative entities established and led by industry, aimed at providing a competitive advantage for companies by harnessing the innovative capacity of the research community. EI issued a competitive call for a research institute to host and co-ordinate the water and wastewater competence centre this February.

"The availability of venture capital is always an issue," O'Callaghan continues. Other challenges that W3 is working on include independent verification of the technology (see panel) and the need for demonstration sites. Water infrastructure tends to have a long life, so the uptake of new technology can be slow, but the companies that spoke to Technology Ireland insisted that Irish local authorities and pharmaceutical multinationals have been very open to providing demonstration opportunities. In addition, the EPA has funded a test-scale demonstration treatment plant in Galway to the tune of €400,000.

But this only part of the equation. Paul Butler, an industrial commercialisation specialist with Enterprise Ireland in Shannon, who has been engaging with W3 for the past two years, agrees there are some specific challenges around the Department of the Environment's tendering rules. There is a requirement to use 'proven' technologies, which, in this context, means technologies that have been already used at three sites of a similar scale and with a similar waste stream, creating a chicken-and-egg obstacle for novel technologies.

Lack of enforcement is also an issue, says O'Callaghan. "As long as we can flaunt the regulations, it is really difficult for a company that has a cutting-edge solution to start in the home market. We know that we have issues, because the EU has pulled us up on certain things in relation to biosolids application to land. There is room for tightening, and I think the EPA knows that. Some of it comes down to resourcing, but there's an opportunity there in itself for the use of automated sensors, and the EPA is quite interested in smarter enforcing policy."

Compliance could be better in some areas concedes, Dr Brian Donlon, head of research with the EPA. "The EU is taking a case against us in relation to septic tanks, but Ireland has been a lead performer on the Water Framework Directive (WFD). In 2007, we were ranked first out of the EU27 for reporting compliance on WFD. Engineering consultancies like RPS have built up masses of expertise, which they could transfer to the newer member states."

EU ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAMME PROVIDES BOOST FOR INNOVATORS

"We are going ahead as one of the first bodies to participate in the EU Environmental Technology Verification programme, which is designed to help provide independent validation of technology," says W3's Paul O'Callaghan.

The ETV, currently in the pre-programme stage, provides the possibility for technology manufacturers to have performance claims for new technologies validated by an independent third party. Its aim is to help developers and vendors, especially SMEs, provide objective and reliable evidence on the performance of new eco-technologies arriving on the market, in order to convince first investors and then customers.

"It would be a big help to allow smaller companies to get an evaluator to look at their technology and confirm it does what it says on the tin, which would hopefully allow it to be accepted on the European market," explains EI's Paul Butler. Biotector's Martin Horan agrees. "We are actually going through approval for the UK at the moment, and it's quite an expensive exercise. The disappointing aspect is that it only applies to the UK market, so the idea of a verification facility that would be European-wide is very, very attractive."

See: http://ec.europa.eu/environment/etv/index.htm

REAL-TIME MONITORING AND ENFORCEMENT In terms of innovation, Dr Donlon also agrees there is an interest in technology to support real-time, smart enforcement monitoring among water regulators such as the EPA. "What we're talking about is a system whereby, when you turn on your computer in the morning, it can tell you if the River Lee is contaminated. Another emerging trend is towards early warning systems, so people won't have been drinking compromised water for a couple of days before we realise there is an issue." Both would require real-time analysers that are sensitive but robust enough to stay in the water without fouling.

This is precisely the niche where Biotector in Cork operates. "What we make is effectively an automated laboratory for measuring TOC [total organic component]. It goes online, connected on the process, measuring in situ and in real-time. At this stage, we have shipped to most parts of the world, but the European block and the US would be our two biggest markets, " says CEO Martin Horan.

"Primarily, we measure water and wastewater and process water, so it can be used in any industry. About a year ago, we signed a European distribution agreement with Hach Lange. They approached us: the fact that they wanted to take on our technology is a huge endorsement."

Biotector has invested €1.3m in R&D over the past three years, and a project just coming to fruition has allowed the company to add phosphates and nitrates to its analytical capabilities. A second three-year project is geared at developing cheap and robust analysers for measuring hydrocarbon content in condensate from oil refineries.

Interestingly, Horan says that the European phosphate and nitrate directives have yet to drive demand. "Unfortunately, municipal treatment plants don't tend to spend money on automatic analysers, so from a regulatory and a payback point-of-view, industry would be a stronger target."

Traditionally, has been difficult to analyse in-flows to a treatment plant, due to the dirtier nature of the samples. But Biotector has been able to demonstrate that its kit is well up to the challenge, and this has opened up a new market, allowing industry to identify where various waste streams are coming from. "Because the technology survives, they can start to go upstream," he explains. "A large production facility might have six or eight different process plants, and you can now start to install analysers on each individual process and identify and address the source of waste, so you get better operation of your treatment plant, you can minimise your process losses and get an early warning if something has gone wrong. The payback in industry can be rapid."

> "Florida is a major supplier, but there just isn't enough of it in the world to go around. It looks like we are going to hit peak phosphorus by 2015."

EI's Paul Butler believes that internationally municipal authorities will also have to start embracing innovation, as the energy costs associated with wastewater treatment become prohibitive. Not only that, but phosphorus and nitrogen – the scourge of aquatic ecology, but primary feedstocks for agricultural fertiliser, are themselves becoming constrained. "A major supplier at the moment is Florida, but there just isn't enough of it in the world to go around. It looks like we are going to hit peak phosphorus by 2015, so there may be a market for nitrate and phosphate capture."

Irish companies can sometimes make the mistake of over-competing in the very small home market, while missing opportunities to work together to capture bigger international opportunities. But not Biotector. Martin Horan is excited about the prospects of getting involved in shared research through the new competence centre, perhaps working on a product incorporating a number of technologies from the W3 partners. The future looks blue – but in a good way.