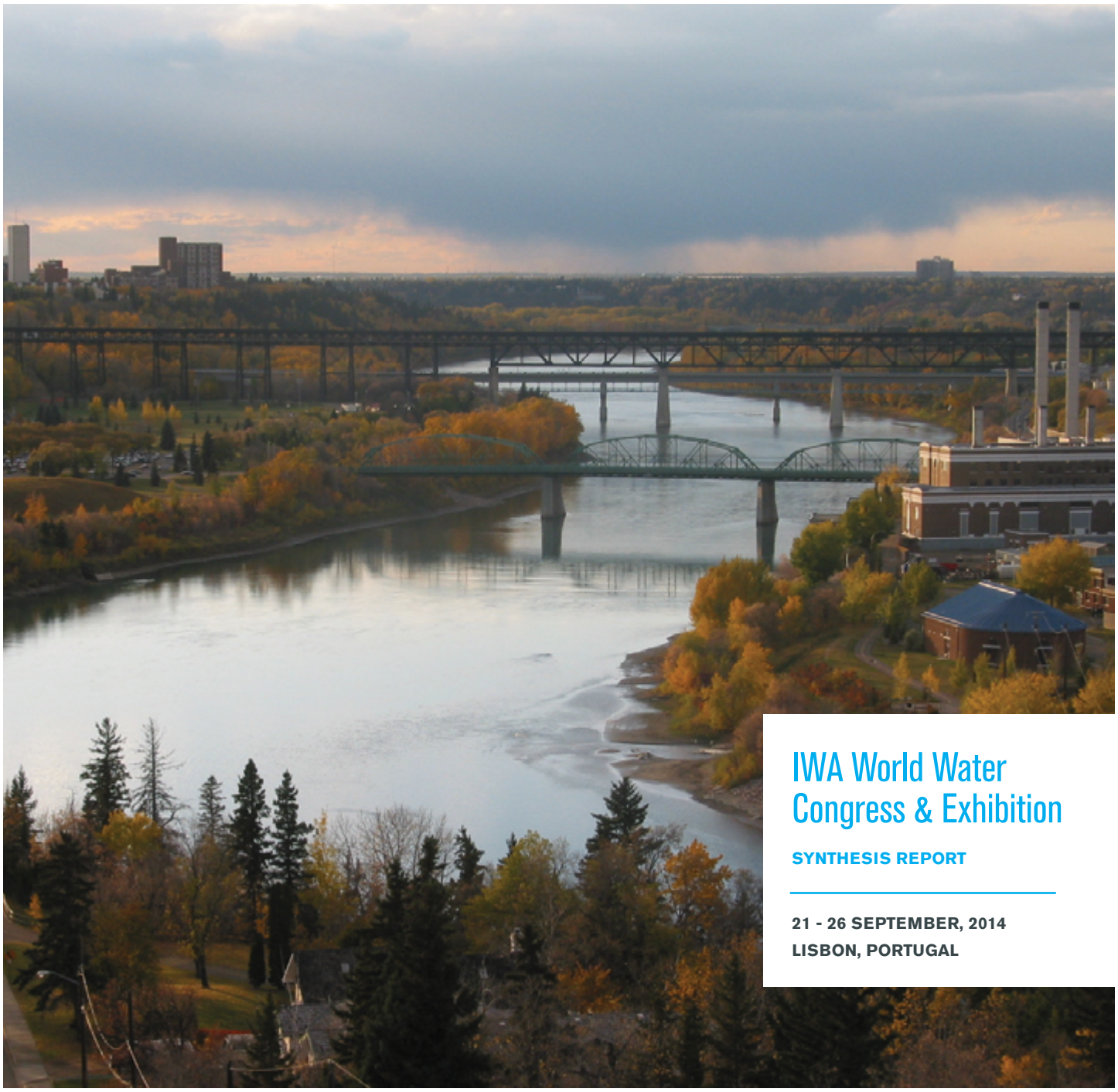
Shaping our Water Future

the international water association



IWA World Water Congress & Exhibition

SYNTHESIS REPORT

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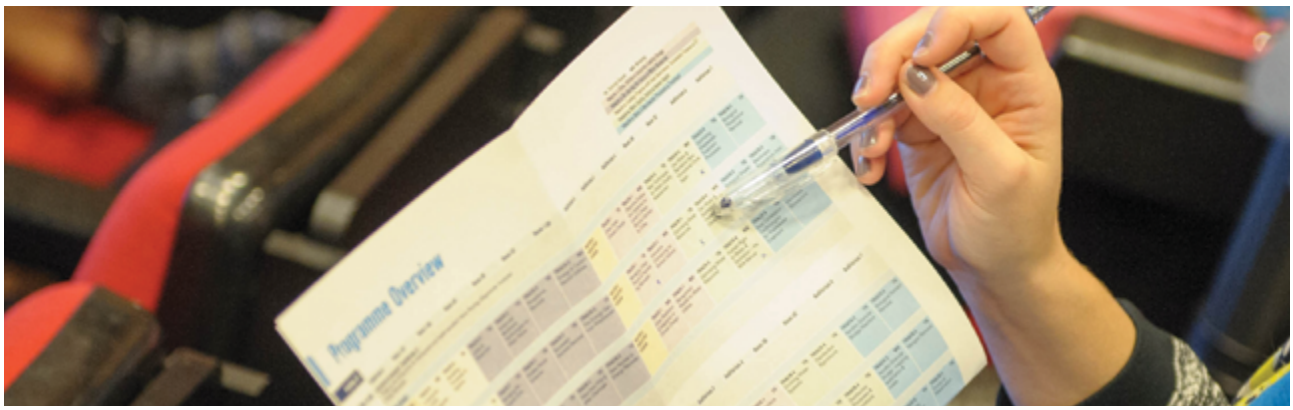
Contents



To Seek & to Solve: From New York Deliberation to Lisbon Delivery

In late September 2014, global attention focused on two assemblies separated by five time zones across one ocean. New York and Lisbon hosted influential gatherings to advance human progress in the face of escalating competition over finite natural resources, in particular: water.

In New York, the United Nations General Assembly deliberated 17 Sustainable Development Goals proposed for 2030. Among them SDG 6, to "Secure water and sanitation for all in a sustainable world." That marked a dramatic promotion from fourteen years earlier, when the Millennium Development Goals quietly relegated water to a minor subset category. Today the UN's Open Working Group fully recognises water's central role in society, elevating the matrix of life as its very own goal.

The boost in stature encouraged those at the IWA World Water Congress in Lisbon. The way we manage water defines where and how we achieve economic development, human well-being and ecological sustainability. "It is essential that the SDGs include an integrated and dedicated water goal," said **Chris Hemans**, Senior Urban Water & Sanitation Specialist, WSP World Bank, Nairobi. "It has to emphasize equity and quality, and not access only."

Yet the water professionals gathered in Lisbon also understood that water never did or could just 'stand alone,' in isolation. They knew clean, secure, affordable water and sanitation remained far more than merely a goal to reach for, an aspiration to attain, or an end result.

Water is the key means to an end – to unlocking our full human potential. As **Hans Rosling** *(video)*, Gapminder Institute, illustrated in a powerful opening keynote,

secure access to water and sanitation translate into health (through reduced exposure to spinal injuries from carrying water, diarrhoea, or rape), income (converted into stable livelihoods), education (providing more hours per day to learn), empowerment (liberating children and especially women) and energy (powering local micro-grids) for billions of people.

In short, water is less a milestone *of* development than the pre-requisite *for* development.

To that end, in Lisbon, IWA delegates showed how versatile water can be. They sought to govern this fugitive resource. They identified water as the tangible medium through which climate change, up in the atmosphere, becomes manifest down on earth. They argued over the finite, yet renewable and reusable, nature of water. With limited water for a growing world, they sought efficient ways to fairly determine who gets how much, for which purposes, at what price, under which rule.

In seeking efficiency, Lisbon positioned water as the fuel of sustainable, profitable industry, the catalyst of productive agriculture, the liquid force that turns or cools turbines, and the source of life on land, in rivers, and through estuaries that nourish the oceans. In short, it revealed water as the currency of the 21st century.

Back in New York, the UN General Assembly battled to forge goals that were reasonable, measurable, and actionable. They struggled to prioritise

targets, based on quantitative criteria to measure progress by 2030. Provision of "universal access to safe and affordable drinking water, adequate sanitation and hygiene" required a focus "at homes, schools, health centres and refugee camps," while "paying special attention to the needs of women and girls." Nations had to improve water quality by "reducing pollution," and "improving wastewater management by x%." The world must enhance "efficiency across sectors," and "integrate management" upstream and down, and at the same time "protect and restore ecosystems and aquifers." To meet targets, governments should "provide adequate facilities and infrastructure, both built and natural" for "mitigating the impacts of water-related disasters."

These are weighty issues. Yet New York's challenges differed from those facing IWA's Congress in Lisbon. It is after all one thing to set goals over the next 15 years. It is another and far harder undertaking to be the people and organisations aiming to surpass those goals and targets. It's no help to say 'use water sustainably.' Everyone already knows that. What we seek is how to do so. That meant fewer reports suggesting what 'should' or 'must' be done, and more attention paid to what 'can' be done. So while New York raised the bar, Lisbon set out to clear it, with room to spare, clocks ticking and agendas conflicting.

And that's when Lisbon revealed its innovative, can-do, collaborative character. IWA Congress President **Jaime Melo Baptista**, ERSAR, recalled how, in planning stages, he sought to anchor competing aspirations for water through an immodest proposal: assemble the world's first Water Regulators Forum "to establish sound water governance systems and stimulate innovation."

How many regulators would attend? Baptista had no idea, so chose a nice round number: 100. "Everyone seemed happy," he recalled, "and gave me approval to go ahead. Then I got home, looked in the mirror and thought: 'You are a stupid guy. There's no way that many people would show up'." He was right. But in fact the global thirst for solutions attracted twice that many regulators, from 60 different countries. "This is the first," Baptista said on the eve of the Congress. "It won't be the last."

His experience epitomised the essentially pragmatic spirit of the IWA Congress. Water managers everywhere face serious trials. By 2030, with another two billion humans, the world will demand 40 percent more water than the earth supplies. The odds are high; risks of failure mean life or death.

Yet rather than shy away from the gap between demand and supply, IWA professionals plunged into it. Far from a burden, water was to those in Lisbon a source of fascination, of creative friction, and of endless delight. Where New York's assembly saw in water a series of looming crises, Lisbon recognised a spectrum of opportunities.

Those of us in water chose, voluntarily, to grapple with the most extraordinary, complicated, essential and dynamic force of life on earth.

To be sure, the work was demanding. And the outlook for water fed a sense of urgency. Yet across hundreds of papers, workshops, presentations and keynotes in Lisbon – of mechanical engineers, naturalists, doctors, hydrologists, social workers, chemists, lawyers, students, statisticians, business managers, linguistics professors, nanotechnology researchers or microbiologists – the women, men and young water professionals in Lisbon embraced the stark reality of water with relish.

As these pages illustrate, the work of 'Shaping Our Water Future' is rarely short, simple, clean or direct. Like a river it meanders, seeps, rises, muddies, eddies, and slows. But beneath the surface, it never stops.

Harro Bode, Ruhrverband, celebrated the richness of this ongoing process. Decades earlier, after submitting an abstract into one of twelve tracks, he was allowed to present the last paper, in the last session, on the last day. "As I began speaking I counted 50 people," he recalled. "By the time the lights went up at the end, there were four people left in the room." Setting aside ego, he decided to "go, reach out to those four, and talk with them, because those were the ones who could make a difference through interacting."

"Defeat is never fatal," Bode concluded. "While the challenges are great, the catalytic energy of the IWA is more than up to the task." And whatever the obstacles, he added, "we must always remember how lucky we are."

Why?
"Because life chose us to pick water for our careers."

Efficiency & Sustainability

In water, past is prologue.
In the 1960s a boy was working on his family's pig farm. "You learn from nature," he recalled, decades later. "The real world requires you to do certain things: harvest corn; feed it to pigs; use pig waste to fertilise cornfields." He saw a closed, tight loop, with water efficiency at its heart. "You could see the science at work up close. You realise innovation doesn't happen in a library – it is a social process of learning across generations, and from each other."

A world away, another young man – raised in a town with no public services, no running water, and only a pit latrine out back – pondered his career. He had studied foreign languages, piano, diplomacy. But as he watched a local industrial pulp and paper factory add to the sewage overflow, undermining the health of a nearby lake, he heard his calling. It was not enough to stop the phosphorous content, but to restore the integrity and resilience of nature. "I saw the capacity for going beyond avoidance," he recalled. "To think and become part of the system, and break up wastewater, and to make the waters clean again."

The boys grew up to become, respectively, IWA's outgoing and incoming president, **Glen Daigger** and **Helmut Kroiss**. By exploring the most efficient and sustainable ways of water, each helped their nations, the U.S. and Austria, progress to become among the world's leading economic drivers.

They could have chosen any career. But from an early age, their decisions were shaped by interacting with the world around them, and with those who shared a similar passion for water.

Never before has that passion been more in demand.

The world holds 4,000 km cubic meters of water, most of which we use. In two decades from now we'll demand 6,000 km, while trying to alleviate poverty and grow the economy.

"People have always known that water is strategic, but it was abundant," said Daigger. "Now it's scarce, and that changes perceptions." A recent Arcadis poll found three pressing water issues to be: scarcity, climate instability, and quality. The absence of water security tops the list of global risks.

On Daigger's farm, water irrigated corn, boiled on the stove, and "kept pigs happy." His family wasn't forced to allocate or rank one use over another. Today, at every level, scarcity makes us prioritise.

What the IWA Congress showed was how private industry, public officials, water managers, business executives, civil society leaders, and utility heads were all now collaborating over how to turn escalating risks into real opportunities, to transform current liabilities into future assets, and to create tangible benefits for society well beyond the water sector, pushing beyond urgent needs to surpass expectations.

How do we convert ugly crises into hopeful prospects? One way of approaching that question, each day, across countless sessions and workshops and governance levels, brought leading water professionals to converge on a pivotal word at the intersection of efficiency and sustainability: value.

Put simply: *What is water really worth?*

The Price of Everything and the Value of Water

The worth of water lies, like beauty, in the eye of the beholder. It rises, falls, and varies by time and place.

"Water means many different things to different people," observed **Francisco Nunes Correia** *(video)*, Portugal's former Minister of Environment, Spatial Planning and Regional Development, 2005-09, "depending on whether they are engaged in energy, agriculture, nature conservation, or urban utilities."

Valuing water demands painful choices by decision-makers, with political risks for public regulators and private operators. People who rent from a natural monopoly don't see the benefits of paying more for water and sanitation; most naturally take existing services for granted. Many assume they should be free.

Water is free – for those who choose to go to a river, fill up buckets, haul them home, sterilise water with chlorine or heat, and dispose of waste streams in a way that doesn't impact your neighbour. Everyone else is bound together in an integrated economy of reservoirs, filters and pipes.

Uniquely, the water industry alone wants clients to consume less of the goods and services it sells.

Views may differ sharply on water's value. In Lisbon, some professionals stressed that water is a social good, others described it as an ecosystem service; anti-privatisation protesters outside the Congress maintained it was a human right and should cost nothing. Parties did agree that competing needs for water would all gain through greater efficiency. But efficiency wasn't free, either. It required human and financial resources. And until recently few posed water efficiency as an investment opportunity.

To cover costs of efficient water delivery or treatment services, money may come from end user fees, taxpayers, cross subsidies, foreign aid, or private grants. But someone has to take that first financial step. Ironically, it becomes much easier to monetise the return on investment in developing countries.

There, a dollar sunk into water and sanitation has been shown measurably to generate seven to ten times as much value in economic growth. From that perspective, paying for water and sanitation is a bargain.

Harder to grasp, noted some in the Utility Leaders Forum, is what users buy when they pay water and sanitation bills. They pay for dams, dikes, pipes, pumps, heating, treating, lifting and moving. They pay for energy embedded in water, and for skilled labour of men and women who fix leaks and repair sewers and treat water flushed away. They pay for access rights, and for legal adjudication. They pay, in short, for the entire complex natural and physical and human infrastructure surrounding the waterworks system.

But they don't pay for the actual wet stuff. Water itself remains, quite literally, priceless.

And in a globally integrated economy of goods and services, *the absence of a price signal in the supply chain makes some in industry feel uneasy and allocate their other resources accordingly*.

Water Becomes Our Business

When semi-nomadic people in the arid Sahel don't interfere in another's business, they say: "It's not my water." Yet in the industrialised world, water has now become everyone's business.

Food, beverage, textile, manufacturing, oil, gas and mineral extraction companies no longer count on clean, cheap and abundant water. They know better. As broken, intermittent, dirty or dwindling supplies can grind any business to a halt. Shareholders, Board rooms and CEOs recognise water poses a critical and material risk.

Unprecedented scarcity has exposed their brand, their reputation, their operations and their finances to high levels of uncertainty. Businesses hate uncertainty, and start to take water into their own hands.

"Four years ago the textile industry approached us, from 'outside' the water sector, to replicate and scale up lessons within it," said **Torgny Holmgren**, Stockholm International Water Institute. "There's too many government silos, so further decisions are being taken by industry, agriculture, and households."

Executives hire outside consultants and in-house water experts. Beyond traditional roles in banking, baking chocolate, brewing beer, pouring coffee, processing food, or extracting minerals, they became de facto water managers: doing more with less. "After all," as one put it, "what choice do we have?"

Beverage industries are among the most water-dependent, and thus most vulnerable to flux. For them, efficiency is becoming an obsession. For example, 55,000 Nescafe cups are consumed worldwide every second; reducing water usage per consumer saves more water than the amount used while manufacturing the cups. "To invest in efficiency," said **Carlo G. Gallli**, Water Resources, Nestlé, "the payback time must be reasonable, and the saved water needs to have value."

Scarcity-driven necessity may be the mother of innovation. But efficiency is only part of the equation. From growing thirsty hops and barley, to producing and shipping products, water is the key ingredient to every aspect of beer. Brewers plan and adapt accordingly. **Jan-Willem Vosmeer**, Corporate Social Responsibility, Heineken International, finds ways to reduce evaporative loss during beer making. He engages the upstream communities and plans sourcing in water stressed Mexico or over-pumped Indonesia. Efforts pay off in corporate image, cost savings, and operational security.

Enlightened self-interest is a powerful driver. In water, "any improvement in quality must be a benefit both for us and for the environment," said **Anna Halpern-Lande**, Royal Dutch Shell. "If oil is removed from the ground, then water or gas needs to replace the oil in order to keep the pressure in the ground. So for us risk management is not a problem, but rather an opportunity."

This outlook can unearth hidden treasures. It is not enough to "avoid mistakes, like underestimating exposure to climate change floods and droughts," said **Rene Hoeijmakers**, Arcadis. "To become proactive, not reactive, industries need to ask, and answer: what would be the best game changer?"

To leverage efficient and sustainable approaches to water, one of the biggest game-changers turns out to be energy, to reduce costs as well as carbon emissions.

Unlocking the Water-Energy Nexus

Energy grabs headlines. Energy generates buzz. Yet energy cannot exist without its less glamorous sibling: water.

Colorado River droughts can disrupt hydropower for 29 million Americans. A fifth of China's water withdrawals are used to mine, process and consume coal. Global reports calling for 10% biofuels would require doubling agricultural water withdrawals. Energy production cannot take place without water; conversely, water abstraction, cleaning, distribution and consumption cannot happen without energy.

So how do the two sectors unite in a self-reinforcing dynamic? One opportunity leverages climate change. To adapt and mitigate, Portugal combines management of both resources in to foster "comprehensive green growth," reduce waste, and generate a "circular, low-carbon economy," said **Jorge Moreira da Silva** *(video)*, the country's minister of environment, spatial planning and energy.

As nations seek to reduce carbon footprints, the water sector – which produces about 2-5% of carbon, plus other greenhouse gas emissions, on par with the airline industry – offers a field ripe for internal mitigation. Utilities seeking energy neutrality, or carbon-free energy, can slash operating expense in half through efficient pumps, anaerobic breakdown, harnessing gravity or mining waste. Bigger gains come from converting waste-water utilities into resource factories.

"This isn't a matter just for rich countries, involving expensive solutions," said **Gustaf Osson**, IEA, Lund University, Sweden. "The pressure to reduce or avoid energy intensity can alter the field of options for water professionals everywhere." Reverse osmosis may be affordable, yet demands 60-70 percent of energy in the cycle. Energy alters water treatment priorities, weighing chemicals vs. ion exchange.

A joint collaboration between the IWA and the International Union for the Conservation of Nature (IUCN) taps opportunities for cleantech innovations through 'Nexus Dialogues on Water Infrastructure Solutions'. Anchored by case studies, a website, and workshops in Africa, Latin America, Asia and Central Asia, the Dialogues go beyond analyses to share, compare, and prepare real solutions – tactical pricing, dam reoperation, benefits trading, or 'natural infrastructure' – in a specific context.

To shrink the urban water-energy footprint, utilities must engage "the other side of the water meter," said **Steven Kenway**, University of Queensland. End users require 70-80% water/energy for appliances in homes, farms, and businesses, from pumps and pools to dishwashers and water heaters. But water and energy utilities are kept apart in silos, said Kenway, and rarely cooperate "especially where revenues depended on high consumption, and there's no business case, or reward, for utilities to benefit."

That's changing, fast. Smart meters, psychology, reporting, and economic signals drive down demand for water and energy. Australia has one minister for both water and energy. Texas and California utilities combine databases to share savings. And the nexus extends beyond two resources, to food, fibre and fuel.

Farmers irrigate 20% of the world's cropland to grow 40% of food, as well as biofuels. Each year the energy sector withdraws 8% or even up to 40% of surface and groundwater. *All of which leads nations to recognise how energy and water are inextricably linked in a nexus with agriculture.*

Water Austerity Unlocks Agricultural Productivity

First, bad news: earlier in the century, regional droughts combined into grain scarcity to spike global food prices. In the new norm of extreme flux, one peak triggered countless urban riots, and contributed to the Arab Spring.

The world's fresh water is maxed out, with seven out of ten litres used to irrigate crops. Looking ahead, our growing, urbanising, affluent populations translate into hungrier and thirstier demand for 60% more food, including more meat, which requires 100 times more water for the same protein.

In this vicious cycle: farming reduces poverty, which increases consumption, which requires more irrigation and chemicals, which deplete and degrade water, which undermines farming. "Agriculture is currently responsible for 70% of global freshwater withdrawals," said **Jeremy Bird** *(video)*, International Water Management Institute, "and there are limited new supply options,"

Is there good news? Yes. The grim calculus may still add up to a net reduction in agricultural thirst. A virtuous cycle will yield more water for energy, industries, cities, and nature. How? Stakeholders can invest in tighter integration, more democratic tenure, and higher levels of efficiency.

A prominent paper in Nature on planetary boundaries painted a sobering picture. Humans have crossed three of nine thresholds – climate change (carbon concentration; radiative forcing), biogeochemical (nitrogen removal) and biodiversity loss (extinction rate). Irrigation also may have gone past a fourth tipping point of freshwater withdrawals. Yet water-smart agriculture can return us back to security, efficiency and sustainability. "There is enough water," said Bird, "but we must manage it better."

Easier said than done? **Actually, technologies already exist to use water in agriculture far more efficiently; they simply require an enabling environment.**

Genetically modified or drought-resistant seeds are available, but remain controversial. Direct seeding of rice is an option in India; liquorice can be grown with saline water. **Farmers are also borrowing innovations and ideas from urban utilities: in some regions, pre-paid cards let irrigators pump until the money runs out, rewarding austere use, but not a drop more.**

Other steps demand systemic operational, economic, and political integration, said experts. Alternating and coordinated management maximises surface and groundwater through calibrated trade-offs. Today, two of five meals, once grown, are not eaten: half spoil during transport, storage, and packaging; half is thrown out post sales. Higher value irrigation water would help squeeze waste out of a more efficient supply chain, yielding more food consumption for the same amount of water up front. But then what is done to tackle the other 40% of wastage?

An ally of economic efficiency is political equity, said **Mark Smith**, IUCN-Water Programme. By empowering farmers, ranchers and fishermen with clearly defined water tenure, users have incentives to maximise every litre, and produce higher yields with "more crop per drop". With secure water access rights, drip irrigation can flourish. This can do more than generate healthy river flows; it can also improve nutrition, since small holder farms provide 70% of local food, with less than 20% traded abroad.

Fundamental change in water efficiency and sustainability, however, is not about the small, local, isolated and immediate gains. *It meant thinking like a watershed.*

Healthy Basins, Healthy Peoples

In Basins of the Future, terms like "urban water consumers" and "rural water producers" will be seen as a false dichotomy. Not only are populations upstream and downstream interdependent, and interconnected; their capacities and needs are also increasingly interchangeable.

Dipak Gyawali *(video)*, former Minister Water Resources, Nepal, in keynote remarks on risks, social institutions, and the overlap in rural and urban water systems, described a scene: "A woman selling strawberries, with a cell phone, in front of pre-Mogul ruins, a backdrop of high voltage towers, spanning technology across time, space and cultures. Is she urban, or rural, or what is she?"

Engineers must learn to trust local water wisdom, like investing in the capacity of mobile irrigation pumps, through which rural entrepreneurs rescue thirsty townspeople. Seek out cross-sectoral, and trans-geographic investment opportunities along a river. "The heart and soul of the IWA believes that utilities are closely connected with upstream basins," said **Glen Daigger**. "Our expertise may be water for people and industry, but always in context of their watershed."

Downstream, urbanising families, firms and farms, that require more water, are helping finance efficiency upstream to generate excess flows below. Now, who pays? Rural households look beyond top-down centralised sources to leverage bottom-up remittances earned and mailed home by family overseas.

Thirsty cities may be polluters, discharging into rivers. But they may also be victims of water quality problems caused by agricultural runoff upstream. To reduce impacts, these interests can forge tighter upstream/downstream linkages. These interwoven narratives – urban, rural, past and future – are tightly integrated, said IWA Global Water Award winner **Qiu Baoxing**, Committee of Population, Resources and Environment, CPPCC, China. The key is to build a "human-water harmony," in which "we are not doing these things for the current government, but for the next generation."

Cross-sectoral thinking helps avoid future water scarcity and the deterioration of water quality that causes health problems, said Bird: "We need to talk about synergies and trade-offs. With increasing competition, municipalities have a key role to play in bringing different users together to agree on joint solutions."

That key role, in unlocking the value of water, may be found in the headwaters of the parched, water-stressed, Colorado River. Pumping and extracting coal-bed methane (CBM) yields excessive amounts of a local by-product: fossil groundwater. "The downstream value of that water would generate a higher price than selling the gas on the international market," observed **Jorg Drewes**, Technische Universität München, and chair, IWA Water Re-use Specialist Group. "Utilities would be keen on getting this water as an additional supply since it would likely be cheaper than imported water from Northern California (which essentially isn't available anymore), ocean desalination, and potentially water recycling."

So what's preventing efficiency? Uncertain policy. Government roadblocks. Liability issues. Time after time professionals shared countless best practices, game changers, and breakthrough technologies. But since water is a public good, managed under public trust doctrines, nothing will happen without a clear, solid, and progressive legal framework.

"We need regulatory incentives for integrating water uses and efficiency," said **Valentina Lazarova**, Suez Environment. *"We can't bring this about on our own."*

Equity, Governance, Rights (& Responsibilities)

To reach the root of water security, you must peel away three outer layers. On the surface is the physical system, visible to the public: water flows out through taps, toilets, showerheads and sprinklers.
Beyond the wall and beneath the floor lies a massive complex: the pipes, pumps, dams, dikes, irrigation canals, sewerage, and treatment plants of our hidden engineered infrastructure.

Even this manmade system will collapse without the natural infrastructure sources that gather, filter, store, stabilise and transport water: our mountains, forests, aquifers, soils, wetlands, lakes, and rivers.

All three layers make up the traditional bulk of water professionals' work.

Yet the real enabling foundation of water and sanitation has no smell, no taste, and no sound. You can't see or touch it. Few even know it exists. It becomes evident mostly through its absence: when the other layers seem to fail time after time. For without governance, water security unravels into water anarchy.

Like a three legged stool, water security rests on technology, civil society, and governing institutions. "Governance means providing leadership, building social consensus, setting goals and reaching targets," said **Francisco Nunes Correia**. "It demands a more comprehensive view. Often we have the knowledge, the technology solutions, and even the financial means and yet these three elements are not sufficient to face the water challenges."

What made Lisbon pivotal was how officials assembled from every continent both to meet and share experiences with each other – and with their critics – in the world's first Regulators Forum. They focused on how best to ensure human health. They debated viable approaches to set tariffs. They found ways to integrate their work within environmental constraints and connection to the larger community.

Qiu Baoxing *(video)*, in his opening keynote remarks, affirmed these linkages. Under his leadership (from 2001-2013), the number of China's urban wastewater treatment plants expanded sevenfold, increasing coverage from 30 to 89 percent, and growing capacity from 35 million to 150 million cubic meter per day. In short, more than 500 million residents were provided with wastewater treatment/sanitation services.

Yet Qiu was quick to give credit elsewhere. He called for further "exploration of urban water management and economic utilization by promoting a people-oriented approach." He highlighted the countless unrecognised individuals who prepared and promulgated landmark policies and laws under such bland, unassuming titles as "Energy conservation and emission reduction" and "Regulation on Urban Drainage and Sewage Treatment." He praised water professionals as "the backbone of IWA, for without you, your hard work, your intelligence, the future would be dark."

Indeed, out of a past darkness and chaos, the light and order of water governance doesn't just happen overnight, on its own, by accident. It emerges from a healthy and inclusive interaction across generations, interest groups, institutional sectors, genders, and stakeholders.

All are struggling to define rights, codes and what constitutes the appropriate political context of water.

The Human Right to Water and Sanitation

On 28 July 2010, through Resolution 64/292, the United Nations General Assembly explicitly and formally recognised "the human right to water and sanitation" and acknowledged that clean drinking water and sanitation are essential to the realisation of all human rights.

Nobody opposes that right – at least not in principle. But giving it form and content is another matter. When asked how to translate abstractions into day-to-day practice, opinions differ and debates crackle.

There appears to be a fine line between 'protective' vs. 'prescriptive' rights. A grey area also exists between "subsidies to ensure universal access" for all vs. "free improved service delivery" for some. Is a human right to water "inalienable," like life and liberty? Or is it transferable, like votes or property? Catarina de Albuquerque, UN Special Representative on the Human Right to Water, argued that rights and obligations to water access and provision promote, "pro-poor and non-discriminatory service provision." But she is also clear that water must be affordable, not free.

Who sets the timeline or measurable threshold? Sceptics noted that countries with constitutions enshrining the human right to water and sanitation have no better service records than those which have not. "Funds for drinking water and sanitation infrastructures are still (and will remain) very limited," said **Amadou Hama** MAIGA, Director General, 2iE Burkina Faso. "The poorest are still more exposed and have to pay more than the richest for clean water."

Yet the UN's high-level affirmation could boost financial investments. "The human right shows how and why we need to allocate $23 trillion for water systems by 2030," said **Michael Rouse**, Oxford University. "There may be necessary cross-subsidies to ensure this right, and we must get toward cost recovery. But there is a difference between the destitute who can't pay and the reluctant who just won't pay."

Two years ago, IWA set out to help clarify discrepancies, and work with others to prepare an enabling environment. Among the focal areas, parties generally agreed that before large scale agricultural, energy and industrial water users gained access to water, people must have their basic rights fulfilled first. "We see this right as a catalyst, a way to organise our tasks, actions, roles and responsibilities," said **Gerard Payen**, AquaFed. "The right is not simply a standpipe, but a way to set political priorities."

Albuquerque stressed what states must seek to achieve for their citizens, or must ensure their public or private sector providers are achieving, much as Eleanor Roosevelt six decades earlier championed the Universal Declaration of Human Rights: "Recognizing that it will only become meaningful if it reaches little towns we don't see on maps, and helps people who don't even know this right exists."

The UN human right to water and sanitation held national governments accountable for their roles and responsibilities, said **Robert Bos**, IWA Senior Advisor. Yet even that was complicated. There appeared to be no legal mechanism through which petitioners could seek a redress of grievance if they felt this right had been denied them. "The devil, as always, is in the details," conceded de Albuquerque. "We don't expect these rights to be realised overnight, but I do expect them to be realised, starting right now."

When Payen asked leaders how they were implementing the human right to water and sanitation, few, in fact, were. Some saw it aimed at poor nations, not affluent ones. Yet even California – earth's 8th richest economy, where 100,000 people lacked secure access – has enacted a human right to water.

A right becomes reality through the friction of awareness, accountability and debate. *Yet rights often grow strongest when linked to corresponding responsibilities, and vice-versa.*

Who Regulates the Regulators?

Few feel the burden of responsibility for a water system more keenly than those who regulate it.

A regulator answers to public officials, but must also keep a necessary distance. **At the fulcrum of decision-making, regulators oversee tariffs, investments, public health and environmental quality. Like central bankers, they set rules and rates for the circulation of a nation's most vital currency.**

Despite endless papers about good water governance, there is surprisingly little about good regulation. Yet regulation ensures the human right to water and sanitation can be fair, strong, inclusive and credible.

Regulators face extreme weather, fluctuating volumes of water, and pressure to integrate policy, safety, public perception in a consistent and efficient way. "They are among the most risk-averse because constraints on them don't allow them to consult or be as open about positions," said **David Garman**, School of Freshwater Sciences, University of Wisconsin.

When asked to intervene in tense relations between governments, local authorities, utilities and consumers, regulators must account for interests of all stakeholders. Yet they also remain independent enough to transcend an election cycle, or district, or sector, or river basin, or even country. Such power is fraught with risk, controversy, frustration and solitude. Indeed, the work of a regulator can be lonely. "There is," said **Manuel Alvarinho**, Water Regulatory Council, Mozambique, "a feeling of isolation."

Rather than be imprisoned by this isolation and silence surrounding their authority, 220 participants flocked to the first global Water Regulators Forum to liberate themselves, learn from each other, and forge linkages across sectors, networks, geographies, interest groups and generations.

"Over time I saw how difficult it was to implement reforms and close the gap between willingness to change and the reality of status quo," said **Jaime Melo Baptista**, who conceived of, championed and helped organise the IWA Water Regulators Forum. "Regulation is a recent instrument that keeps evolving, and we need to learn and check our experience with others."

Portugal, and Baptista in particular, were in a unique position to catalyse this first gathering of water regulators. On his watch, the country progressed from authoritarian state to inclusive and participatory democracy, then prepared to join the European Union's demanding code. Nations evolve from centralised oversight, toward building trust and institutional capacity to take over a more devolved approach. "There was a strong incentive to change policies, where regulation appears as an essential tool," Baptista said. As Portugal's regulation improved, cholera became a thing of the past, and its beaches the envy of the world.

Environmental regulations, while hardly new, are growing increasingly complex and can't be ignored. Regulators must integrate natural infrastructure, downstream estuaries, the rising cost of energy, and pressure to shrink carbon footprints.

Equally powerful lessons could be borrowed from financial regulators, who balance the expense of day to day regulation with the potential catastrophe of a contagious, country-wide or international meltdown.

In all cases, parties stressed the need to codify consensus about water, and 'put it in writing.'

Expanding Charters, from Bonn to Lisbon

Nothing about clean, safe water is free. But how can society properly value its provision?

When critics complained about the high costs of regulatory oversight, regulators responded that, like taxes, their duties and fees are the price paid for a secure and functioning society.

Yet for years, that 'social contract of water' has been fluid, amorphous and opaque. Today, political accountability requires more clarity, structure and formality. Much like the human right to water, various customs, codes, rules and norms are being streamlined into one overarching written charter.

A universal, high-level charter makes sense. For better or worse, water crosses boundaries. Rivers transcend national borders. Worldwide, millions of people still lack access to safe drinking water; 2.5 billion people lack access to sanitation, and open defecation is the reality for nearly 1 billion people.

With such high stakes, IWA has been working with regulators to develop a new set of principles, based on its Charter for Safe Drinking Water, set forth 14 years ago in Bonn, Germany.

That document, known as the **Bonn Charter**, set out the principles of an effective drinking water quality management framework and the responsibilities of key parties to achieve it. The Charter's framework for drinking water safety incorporates the development of water safety plans. By adopting the principles and responsibilities of the Charter, water suppliers demonstrate their commitment to improve and maintain the reliability and safety of drinking water.

To chart a way forward, professionals sought to integrate lessons from Water Safety Plans. "These brought a more transparent and shared approach to drinking water quality," said **Dominique Gatel**, Veolia. "They improved and professionalised the dialogue between water suppliers, authorities and customers." Yet safety plans also allowed locally flexible responses. Some nations considered the plan a legal obligation to water suppliers; others preferred to expand pre-existing elements already in place.

Today's challenges have grown more complex and diverse. Water is inextricably linked upstream and downstream with resources, treatment, energy, climate, biodiversity, agriculture, sanitation and hygiene. To meet competing needs, the Water Regulators Forum began to draft a bold new charter.

The Lisbon Charter on Water Regulation, said J**aime Baptista**, "sets out a framework for regulation and regulators on a global scale." It speaks the same language as the Bonn Charter, and the two naturally complement one another with roots in safe and protected resources. But the latter differs with broader targets, more integration and interfacing, and a larger scale of analysis.

Elements of the **Lisbon Charter** include: establishing universal safe access; increasing water efficiency; augmenting water re-use; creating water resilience; optimizing water - energy linkages; and recovering resources from the outflow stream.

Regulating that poses a formidable challenge. But water professionals driving their systems to security can accomplish all this through: greater scientific and technology innovation; strong policies and regulatory institutions; and appropriate tariffs for financing assets; and more stakeholder engagement.

And key stakeholders to be engaged through this Charter were increasingly female and young.

Broadening the Equitable Foundation of Water

A paradox of water is that women and children are locally responsible for managing it – up to a point.

Throughout the rural developing world, women and children gather water. They transport water. They negotiate for water. They debate water's real value and appropriate usage. They barter water as currency, and allocate it for cleaning, washing, cooking, or irrigating a backyard subsistence garden.

But upon crossing an invisible socioeconomic threshold, scale, or point of prestige, men take over. Today males dominate the water profession especially at the senior and managerial level. And if no women are present to 'lean in' at water's decision-making table, their voices can get left out, muted, or ignored.

Happily, quantity in the profession is never a match for quality.

To balance the equation, and highlight outstanding accomplishments, IWA recognised outspoken and highly competent women whose leadership drove change throughout the sector.

Sue Murphy *(video)* runs the Water Corporation of Western Australia. She has been listed among the country's top 100 most influential engineers.

Yet when it comes to influence, she felt "humbled, almost a little bit fraudulent," by those outside the sector, who inspire change and influence water for the future: mothers.

"We need to encourage more women in the water sector, because water is not just or even mostly about having technical skills, but rather influencing skills," said Murphy. "Organizations reflect their makeup, and institutional change requires a new mind-set. And when it comes to changing someone's mind on how they behave, I can think of no better person than a woman."

Leading that change in political mind-sets are two women from the next generation, Young Water Professionals. Picking up the torch carried by women like Murphy is **Inga Jacobs**, the Water Research Commission's (WRC) Executive Manager for Business Development, Marketing and Communications. "IWA has been my classroom and my playground," said Jacobs, upon winning the prestigious 2014 Young Water Professionals (YWP) Award. She represented a new cadre of thinking, and a fresh perspective on the male-dominated sector. In particular, coming from South Africa, she brought greater "recognition of the skills gap, and how to close it, in the developing world."

A more diverse community allows for more innovative approaches, and **Norhayati Binti Abdullah**, newly elected chair of IWA's Young Water Professionals, emphasised the progressive steps needed to attract more women like her into the sector. "I think it's appropriate to make water women's business again," agreed Murphy, "because I think women generally care more about the community role of water, community expectations for water, and the success of water in their community."

But what really constitutes 'success' or 'expectations' in our dynamic world of rapidly evolving rights, risks, roles and responsibilities? What, for that matter, constitutes a water utility 'community'?

For years water professionals lacked a global, comprehensive, rigorous, yet flexible standard that could answer those questions.

So they developed one that did.

Pushing Beyond Benchmarking

IWA's World Water Congress attracted 5,000 delegates, and hosted 220 participants in the first Water Regulators Forum. But even those record numbers represented a drop in the proverbial bucket, given the diverse scope, vast scale and complex dimensions of the fragmented global water sector.

How can the millions of professionals not in Lisbon learn best practices? How do they know if they are making progress? Against whom can they compare, with thousands of utilities globally?

Each utility has its own unique history and contours, noted **Enrique Cabrera**, Universidad Politécnica de Valencia. Systems may be private or public, dry or wet. They serve large or small constituencies in affluent or poor economies. So there is no uniform metric, and typical benchmarking doesn't make sense.

At the same time, investors hesitate to fund an industry with no way to assess needs, chart progress, or set priorities. And calls for structural tariffs and reforms demand a deeper analysis of water and waste-water operators. These pressures led to the creation of a system known as **AquaRating** *(video).*

The concept emerged in 2007 through the Inter-American Development Bank and its work with clients. It took three years to develop, and two to test with a cross sampling of small, medium, large, public and private utilities. The structure identifies 450 indicators along 100 elements, organised in eight categories. Each element is assigned a rating, which aggregate into a unique 1-100 utility score.

The system is voluntary, but requires four months evaluation and payments up-front. Why bother? What's the return on investment? AquaRating sets a utility on a path for certification, renewed every few years. That helps it justify higher tariffs or win new funds from private investors or public bodies.

An encouraging aspect of AquaRating is that "even the best performing utilities can find where they could make improvements and know precisely what they had to do to improve," said **Sergio Campos**, Inter-American Development Bank. Ratings are confidential, even for public utilities, but over time "show improvement and document progress to earn more trust through transparency and accountability."

Rather than limit potential by region, or market only to the rich, AquaRating partners with IWA. It is projected to become a self-sustaining mechanism, providing a unique service open to the entire industry.

One overriding lesson of the pilot is that the rating process is, in many ways, the product.

The effort to reconcile competing water pressures– quality, efficiency, equity, ecosystems – can cause analysis paralysis. AquaRating gives leaders a road map, identifying what to fix now vs. later. "People learn what questions they should be asking," said Campos, "and find where they are weaker than they had assumed, or stronger than expected. The system helps the general manager set priorities, and decide what backlog he or she should do first, for the most important and cost-effective outcomes."

Thus AquaRating helps utilities become not just effective, efficient and equitable, but also more resilient.

Resilience

Lisbon's smooth Congress was disrupted when a sudden furious downpour flooded streets, stopped cars, disrupted trade, and kept participants from sessions. Similarly sharp, heavy storms in Germany caused 500,000 Euros damage to Harro Bode's utility, delaying him: "Weather patterns are changing."

This highlights a vexing water and sanitation challenge: a resource can flow clean, with efficient delivery of healthy and equitable outcomes. Yet the system can still be overwhelmed by shocks, and collapse.

Climate change is but one shock, a threat multiplier that could simply amplify existing stresses like globalised trade, violent conflicts, disease vectors, government shutdowns, demographic shifts, or natural disasters. Other catastrophes aren't limited to sudden outside shocks to the system, like: oil spills, earthquakes, hurricanes, deluge and drought. Some come from within: like financial crises, careless regulation, sector re-allocation, or a labour shortage that drains talent from the sector.

Asia and Africa face shocks from explosive, youth-driven growth. But parts of Europe, Japan and North America are cursed by the opposite: a shrinking, aging population that demands less water and sanitation, and believes, reasonably, that it should pay less accordingly. When Lisbon lost 500,000 citizens from its inner city, said **Luis Branco**, EPAL, it had to optimize existing resource systems.

Upstream disturbances disrupt downstream cities, where more than half of humanity works, eats, drinks, and burns energy. By 2050, 70% of the world's population will live in urban areas. This impacts hardest in emerging

economies, where growth strains existing resources to the breaking point.

To prevent rupture, it is no longer enough for water systems to be 'robust.' They must become resilient.

Scientists describe resilience as "the ability to absorb disturbances," and "adapt to stress and change," yet still "retain the same basic capacity for self-organization and transformation." It means resilient water systems can bounce back from hard knocks, and keep a stiff upper lip.

But no one knows which disturbances will arise when, from which direction, how intensely, or what the "new normal" will feel like. Few water crises can be predicted, much less quantified. Threats often arise exactly when water managers feel most prepared and confident.

Water resources – natural and built – face interdependent and thus more complex stresses. As a rule of thumb, the economic, societal, or ecological life of a city's water system grows resilient to the extent it anticipates and minimises exposure to risks while maximizing exposure to downside benefits.

So how do we de-risk water, and build resilience for cities of the future? Looking ahead, the success of our 'grey' systems, said **Alan Vicory**, Stantec, depends on integration with green, 'natural infrastructure.' But benefits of the latter must be shown to be cost-effective, or superior to traditional built approaches.

Rigorous outcomes require flexibility. A constant is our need to adapt. The only sure thing is uncertainty.

And the opposite of uncertainty is wisdom, where experience combines with knowledge, informed by data.

Shock-Absorbing Water Systems

Water professionals get it. They aren't in denial. They sense the nature of looming problems.

They see temperatures and sea levels quietly rising. They monitor groundwater salinity, and watch glacial ice become snowpack, then rain. They notice dry spells getting drier, wet seasons getting wetter. They release dams' winter storage ahead of spring flash floods, then watch reservoirs evaporate in summer.

"But up to now too many water managers are still working as if planning is a luxury," said **Paul Brown**, University of South Florida. "We know how to store, lift, move and treat water; but in many cities we need to start asking whether there will be any water left for us to work with, and what happens then?"

Contrast risk – with known cause and consequence – with uncertainty, where everyone lacks knowledge or even knows what's knowable. Uncertainty is best fought by tapping into the wisdom of crowds. After Hurricane Katrina knocked out New York, planners sought how to adapt to future storm surges. The winning solution was crowd-sourced.

Cities rarely put back what failed during a disaster; they transition to something new. So resiliency emerges through future scenarios that model how cities might adjust post-crisis, and then do it pre-emptively.

They design "cloud-burst boulevards, parks, civic plazas…or nested, semi-autonomous building units," said **Steve Moddemeyer**, CollinsWorman. "These absorb and require half the generated water supply and thus become twice as resilient, which you can replicate and scale up city-wide."

Oddly, our rapid push for efficient economies of scale may undermine resiliency, which favours incremental redundancy. "It's often small-scale, no-regret, flexible, multi-purpose, decentralised, low-cost, distributed, approaches that best meet the needs of the world we're headed into," said Brown.

So why don't we embrace them? Prevention offers no reward. "If the telephone doesn't ring, managers feel there's no need to fix something," explained **Tim Waldron**, chair of IWA's Water Loss Specialists Group. A sinkhole generates headlines, and heroic intervention. "But for every visible rupture there are 40-50 unidentified below in the water and sewage network, and they're getting worse."

Tools can staunch bleeding water and energy. Automated systems detect leaks in real time, against a 3 a.m. baseline.

Manhattan's crowdsourcing, Madrid's 'smart' meters, and Copenhagen's low-impact development offer viable approaches. But those well-resourced and –governed cities are least vulnerable to shocks in the first place. What happens in Lima, Lagos, Maputo, Mumbai, Cairo or Kuala Lumpur?

Resilience principles transcend GDP. "Rich or poor, all cities seek to be sustainable, resilient, and liveable -- not just robust," said **Rob Skinner**, Water for Liveability Centre, Monash University. But avoidance "requires a new planning hierarchy, one that integrates water systems with transportation, energy, and health."

Odds of resiliency appear to grow as cities shift from large-scale infrastructure with top-down rules toward economic incentives with decentralised tools. There's also the time dimension of decisions, of how fast flexible options can be adopted

To prioritize those decisions and options we must fill our information vacuum.

Harnessing Big Data to Calm Troubled Waters

From meters, to billing systems, to temperature gauges, resilient water management depends on data. Big, rich, reliable data feeds knowledge. Knowledge is power. The IWA harnesses it to improve practice.

'Big Data' from agent-based models, real-time 'smart' infrastructure, and cloud-based platforms fuel a new movement known as hydroinformatics. Hydroinformatics brings symbiosis to information technology and water science. It helps stakeholders be forewarned, and thus forearmed.

Consider closed circuit television. Many fear public cameras will speed erosion of our privacy. Hydroinformatics embraces them against erosion of our property. "We re-purpose the historical archives from security cameras in order to prevent future natural and man-made water-related disasters," said **Dragan Savic**, University of Exeter Centre for Water Systems. "Digging into old footage can re-create flood information, developing data by looking at what's visible at various times or places."

Hydroinformatics works like a recipe: combine rainfall data with meter readings; add runoff patterns; control for slope; adjust by surfaces; then fold in radar signals, flood records, and satellite images. The result: useful intelligence that urban planners devour. "The idea is to harness what is out there, from GIS and 3-D expressions of Big Data and the Internet of things," said Savic, "and get to the point where these devices are talking to each other, and to us, to analyse signals for anomalies that allow city managers to intervene in real-time, before it is too late."

Recipes vary by ingredients, design or purpose. IBM's **Cityforward** offers an open platform to integrate urban water data. **TaKaDu**, of Israel, links data sensors throughout a utility network. Professionals showed how rich decision support systems can improve urban wastewater treatment, or how a precise analysis of a wastewater facility's carbon footprint can decrease its emissions. KWR's **Watershare** initiative offers a "milestone for our water research and development strategy," said **Christos Makropoulos**, NTUA. In each case, utilities must define their goals first, so that "more data means more information for better decisions", said **Carlos Campos**, Suez Environnement.

Results have significance in space and time. They anticipate floods, and focus on where damage potential is highest, allowing managers to rank priorities. The 'artificial intelligence' lens reveals a fault – a silent invisible leak underground, a hairline crack – to repair before it gets desperate, expensive, and ugly.

Hydroinformatics are interactive and participatory. They function like your iPhone GPS map: by showing where traffic jams occur in real time, you and thousands of other drivers self-alleviate the worst. In fact, cell phones play a key role. By logging frequency and origin of phone records managers can focus on and verify the nature of any problem, narrowing scope by age of infrastructure or instability.

The aggregation of "citizen science" builds democratic resilience. By sharing risks, hydroinformatics also share the burden and benefits of reducing them.

For example, rather than one 'climate' system, think of countless 'microclimates,' and engage 2,000 private weather stations within a single city to show where it is raining and how severely. "You can plan with more granular data," said Savic, "to model what will happen next."

To model future resilience, society requires more than rich data. It requires enriched minds.

Tapping a Scarce Resource: Skilled Labour

With crushing global demand for water and sanitation, you would think our profession a competitive, rewarding and prestigious career choice of the 21st Century, with skilled youth racing to fill positions.

And you would, alas, be wrong. A landmark IWA study found four out of five nations facing a shortage of human resources in the water, sanitation and hygiene sectors. "**An Avoidable Crisis**" took a hard, close look at the supply of and demand for water and sanitation-related jobs in fifteen thirsty countries.

Bluntly, it concluded "there are not enough appropriately skilled water professionals to support the attainment of universal access to safe water and sanitation." The shortfall, said **Kirsten de Vette**, IWA, can undermine progress for reasons unrelated to money, need, technology, or water itself.

The absolute shortage comes from geographical, generational, economic and educational drivers. The sanitation supply gap is far wider than in water. Females are grossly underrepresented. Rural workforces lagged behind cities. Courses weren't easily available, accessible, or affordable; while training relied on communal knowledge or volunteers, leaving institutions hollowed out and vulnerable to stress.

But demographics need not be destiny. Organisations learned to systematise their knowledge, or invest in new training. Uganda, for example, showed how it had a strategy for developing capacity from below. "The first step towards turning our utility around was generating a new company culture linked to strong values," said **Mamadou Dia**, Senegalese des Eaux, Dakar.

That culture and capacity is evolving rapidly, in new directions, redefining what a water professional is. "It used to be you get a degree in civil engineering, and that was your route in to the water sector," said **Randolf Webb**, Young Water Professional (YWP), Accenture. "Now what's exciting is that you may be coming from international affairs, or social development, with degrees in computer sciences."

Indeed, where many saw only looming crises, the IWA found: "*A World of Opportunities.*" The IWA booklet by that name affirmed that while labour shortages are real, the sector is diversifying and democratizing to meet exciting challenges in the profession. Indeed, "since everyone uses water," said **Tobias Barnard**, past chair of IWA's YWP committee, "everyone works in the water sector."

Those entering the field combine research with real-world practice in new directions, places and teams. **Odete Muximpua**, water/sanitation analyst, works on multi-sectoral teams, from condominial sewer networks outside Lusaka, to wetlands filtration in the Limpopo basin near a small town in Mozambique.

"When you look at whom a utility hires, it tells a great deal about its direction and goals," said **Tom Mollenkopf**, newly elected senior Vice President for IWA. "It used to be all about chemists and civil engineers. Now they seek communications experts, lawyers, economists, and statisticians. If we look at the IWA now, and the diversity of professions that constitute the water sector, I'm spoiled for choices."

The IWA will further spoil members' choices via a new **my-water-career**.com website. Professionals who join the IWA seeking exposure to opportunities tend to be forward looking, flexible, and versatile – character traits that make the systems where they work more adaptive as well.

"Utilities often tend to be big and don't like change," said Webb, "but to build resilience they must become more nimble and adapt: to the aging workforce, plus the difficulty of attracting young talent, plus the need for IT skills in a rapidly evolving regulatory landscape, *while at the same time addressing climate change.*"

Climate-Proof Cities

Picture a city in which it never rained again. This troubling scenario comes not from some foreign, futuristic, science-fiction fantasy like in Star Wars or Dune. It's Western Australia, today.

To endure, Perth adapted. The proportions of water sources shifted and diversified over time. In 1958 **Sue Murphy's** *(video)* mother bathed her daughter in water, which came 97% from dams, 3% from groundwater. Today, as CEO of a 2.6 million square kilometre region, Murphy supplies only 7% of water from dams; 50% from desalination, and 43% from groundwater replenishment.

There hasn't been an 'average' rainfall event since 1974. Reservoir supplies plunged from 350 billion to 30 billion last year. "We essentially lost our entire supply over 15 years," said Murphy. "It's careless to lose, and expensive to recover." In a drying climate, Perth aims to be drought-proof by 2022.

Against a changing climate, Australia pushes the envelope. Wind powers a desalination plant. Deep aquifer pumps recharge and deposit surface water in groundwater "banks." Incentives drive extreme efficiency. And Perth integrates all these sources in seasonal and sectoral coordination.

Technology keeps advancing globally. As coastal cities overdraw aquifers and face salt water intrusion, they integrate subsurface resources into urban water management plans. Others "intercept" brackish and saline water, treat, and reuse it. If utilities convert waste streams back into water, or energy, they can build and maintain a perpetual drought-proof supply.

But engineering provides only one part of the solution. To make supplies last, Murphy had to balance residential equity against industrial demands. To share risks, she engaged the mining industry, dis-incentivised drought time watering of gardens, and partnered with the private sector. The biggest source of water comes from 92% of Perth's community, who reduce their demand to increase total supply.

Water rates, tariffs, or pricing offer powerful tools, and help insulate vulnerability to shocks. But some urged caution, for people see water as different from other goods and services. "Beware the monetization outcome," said **Stuart White**, Institute for Sustainable Futures. "People don't need water; they need the services water provides. And the job of the utility is to provide these services at the lowest possible cost."

The flip side of drought is deluge. Cities also sought resilience strategies to bounce back from extreme hurricanes, typhoons, and floods. Tracking systems allow early warning; decentralised swales and structures to harvest rainwater help slow, store, sink, and solve the severe pressures from sudden runoff. "Rainfall forecast tools alone are not enough," said **Suresh Babu Parasuraman**, DHI Water & Environment, Singapore. "Flood alerts must be linked up to runoff modelling and plans."

There are many tools and pathways to a climate-independent utility. "But first we must think differently," said **Amy Leung**, Asian Development Bank, "and plan cities holistically." Holistic plans demand "Safe and SuRe" (sustainable and resilient) networks against emerging external threats such as climate change, and internal threats such as asset degradation.

To identify threats and solutions, and mitigate while adapting, utilities must learn constantly to innovate.

Innovation

Water professionals see risk through one of three socially constituted lenses.

First are "risk-sensitizers." Men and women in civil society form pressure groups, coalitions, non-profit advocacy institutions. They confront eco-racism, raise the alarm against pollution, health and safety dangers, and warn of biodiversity loss or degradation. They work to reduce vulnerability of the poor, women, indigenous minorities, and natural ecosystems through the language of rights and equity.

Next, in response, come "risk managers." These individuals gravitate toward central institutions, and public management. They develop and codify policies, blanket restraints. They are forever caught in a balancing act, seeking to satisfy the competing needs of as many people and interests as possible, through the language of rules, restrictions, rations, and regulations.

Then there's "risk takers." Where others see water as it is, this group looks at water as it might one day be if they try something unorthodox, or attack the problem from a unique angle. "They are free to explore innovation, and define problems of water differently," said **Dipak Gyawali**, Nepal's former Water Minister. "So you can bet your boots their solutions are going to be far different than those in the other groups."

For example, risk-sensitizers lament the lack of sanitation, alert the press of e-coli contamination of downstream slums and potential for a cholera outbreak. Under pressure, risk managers issue directives, fan out from a centralised base, and pass regulations banning open defecation.

And risk takers? They develop new forms of urine diversion composting toilets. They leverage the decentralised power of cell phone texts to identify leaks or track disease vectors. They seek to trap and harness the methane gas rising from piles of excrement. They screen ventilation pipes to eliminate contamination from flies. They mine sewage facilities to extract nitrogen and phosphorous.

Where others see calamity, risk takers see potential. As cities bemoan 'waste,' they embrace 'resources.' Where many demand rights to push, these few innovators seek incentives to pull.

Are innovators born, or bred? How do you find, foster and fund innovation? They must overcome obstacles, get past hesitation and doubt, wade through trial and error, invest heavily into research and development, and, ultimately, prove to the world what can be done.

To spark, recognize and scale-up game-changing solutions, the **IWA Project Innovation Awards** – in applied research, design, operations/ management, planning, small projects – harness water professionals' innate curiosity, inventive sprit, and competitive energy to elevate teams from around the world that have contributed to building a green economy in an exceptional and inspiring way.

"Whether focusing on innovative planning and communications, recovery of energy, nutrients and materials, or optimizing industrial wastewater treatment," said **Ger Bergkamp**, IWA Executive Director, "all teams have presented leading examples of '*the future is already here*'."

Resource Recovery: Closing the Loop

A family played a birthday prank on a child, filling a box with excrement and wrapping it up with a bow. Upon opening it, instead of crying, the child jumped for joy and ran about the room.
"What are you doing?" a frustrated sibling demanded.
"Well," laughed the child, "With all this manure, I just know there must be a pony here somewhere!"

That child grew up to be an IWA water and sanitation professional.

The 'pony' behind the manure was valuable energy, water, organics, phosphates, nitrogen, cellulose, rare earths, and other resources used to produce 'new' water resources, bio-gas, fertiliser, and paper.

Efficient recovery of urine and faecal 'waste' – especially nitrogen, potassium, or phosphorous – can offset a shortage of the key ingredients for enriching soils. As petroleum-based fertilisers grow scarce, local organic alternatives arise. Extractive industries mine urban sewers; farmers contract for sludge. "Sludge is no longer seen as waste but regarded as a valuable resource," said **Banu Örmeci**, Wastewater Treatment Engineering Chair, Carleton University.

In this paradigm shift, "We no longer talk about 'wastewater treatment plants'," said **Sandra Ralston**, Water Environment Federation. "We talk about using and building 'resource recovery facilities'."

Some feel this shift from treatment to recovery is too gradual, too delicate, too small, too late. For more than a century, cities seeking healthy populations worked hard to dilute and dissipate all these combined ingredients. That culture endures. "Like a magician in a circus," said Belgian professor **Willy Verstraete** *(video),* "we took the matrix of foul water, the bad smell, the suspended solids – and learned how to make it disappear. Like magicians, we remain masters in this technology."

The IWA Project Innovation Awards recognised pioneering efforts in reducing negative impacts. As winner of Superior Achievement, Japan's Nagaoka developed a hybrid rapid filtration system to treat water without energy or chemicals, using gravity as a source. The Global Grand Prize for applied research went to the SCORe Team in Australia, which over five years found how to reduce corrosion and odour in sewers. A workshop hosted by Samuel Martin Ruel, of Suez Environnement, illustrated advanced processes for micro-pollutant removal in central Europe.

Yet in a fast-changing climate, the old systems still burn too much carbon, food, water, heat and money. "One hundred years is enough," Verstraete argued. **"In sanitation we continue to destroy nitrogen. We dissipate potential proteins into sewage. We consume 2% of the world's available energy. A 20-30% reduction in waste is all very nice, but it is not full recovery. It is time for us to close the loop."**

Public and legal obstacles make that hard. Tools alone can't transform negative liabilities of sludge, heavy metals, or bioplastics into assets, said **Peter Cornel**, Technische Universität Darmstadt. "We have the technology, but still are struggling on how to create new demand." The reality is that not everything is valuable or marketable; so many residuals are still seen as waste.

The biggest residual, said Verstraete, is "our reptilian brain disgust of contact with faecal matter." But by dealing honestly with materials, we can surmount 'pushing' new approaches to the 'pull' side of demand. After all, in aquaculture "no one complains, despite eating fish whose diet is 50% based on shit."

In any case, *a truly closed loop demands that we know exactly what resources can be recovered.*

The DNA Revolution in Water Systems

Extraordinary innovations may at first seem obscure, exotic, expensive and useless to taxpayers. Two products developed by government agencies – GPS, the Internet – initially appeared to offer no real relevance beyond military or strategic value. Now these advances are embedded in our lives.

Likewise, the decade-long, $3 billion undertaking to map the human genome through DNA sequencing struck some as an irrelevant indulgence by 200 people in lab coats to interpret the work of God. But this too is being democratised for consumers, with staggering implications.

Gene sequencing order nucleotides – adenine, guanine, cytosine, and thymine – within a DNA strand. Anyone with a few thousand dollars can map their own DNA. Economies of scale drive down prices. Today DNA methods and mechanisms have grown so fast and cheap they can map plants, animals… and complex water, sanitation, and waste treatment systems.

This capacity alters how we engineer the matrix of life. It reveals the secret lives of microbes that drive all water systems. "We can investigate and identify bacterial life forms in water, and discover what they do, reliably and cheaply," said **Per Halkjaer Nielsen** *(video)*, Aalborg University, who notes humans are only five times more complex than bacteria. "We extract DNA from a water or soil sample, chop it into pieces, sequence it and by using bioinformatics tools put it together in genomes for the individual species."

The discoveries become meaningful through a growing list of pragmatic applications. They identify indicator species, which "serve as early warning systems for pathogens, and micro-pollutants, and allow for control strategies." They help "maintain plant stability "by knowing what's in the matrix, and balancing it with the right mix". They can serve as "knowledge banks, like a Google for wastewater."

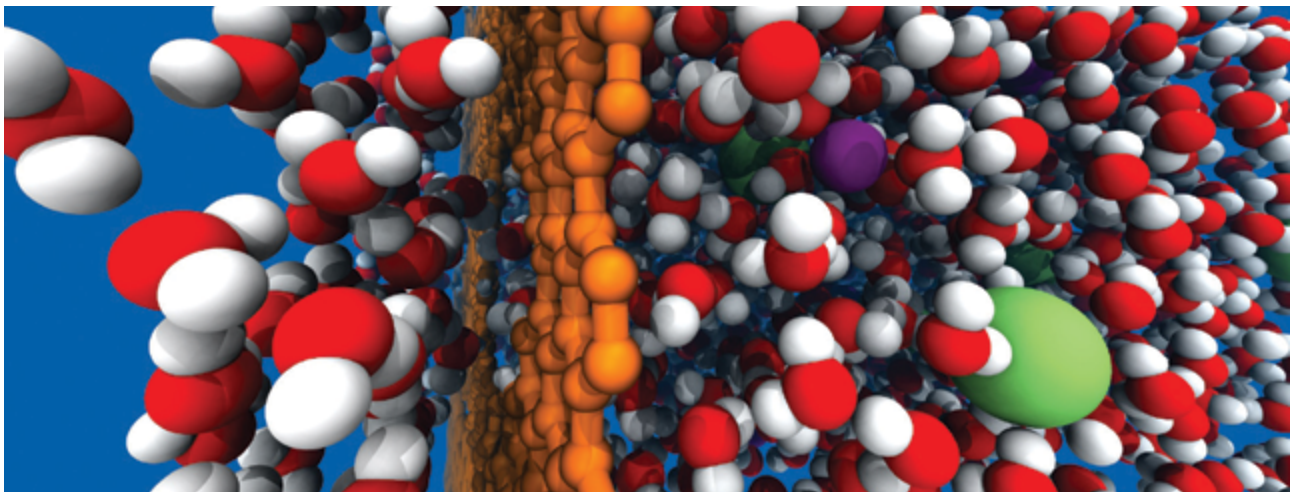
The DNA sequencing process – giving a name and a tag to hundreds of microorganisms – can turn a mysterious liquid into a clearly identifiable table of contents. A microbiome has a particular metabolic function unique to a given place, whether northern China or southern Portugal. Difficulties remain in data generation, handling, and interpretation, said Nielsen, along with cultural barriers. But the mind boggles as the potential power and precision sequencing offers an industry seeking efficient and reliable solutions.

In fact, **the methods of DNA sequencing are helping break down old, artificial divisions between 'natural' and 'man-made' water systems, to better understand what is happening in our surrounding environment. For all our sophistication, we don't really know what a 'healthy' biome is, or how it occurs.**

"Look at the complex bodies of our aquatic systems and the bacterial interactions of e-coli and other bacteria," said **David Garman**, dean of Freshwater Science at University of Wisconsin on the edge of North America's Great Lakes. "Fish populations depend on impacts not just from fishermen or pollutants, but from nano-particles. But through source tracking, mapping the DNA of aquatic species, we can better figure out where something comes from, and sort it out better. We can't ignore the complexity of life."

Through better understanding the DNA of bacteria and how they interact, Garman added, "*We may learn to stop removing invisible things from our water systems, and do better by re-introducing them.*"

Nano-Solutions for Mega-Challenges



Water is more than a molecule. Yet it is at the molecular level that many of our most exciting innovations have begun revolutionizing the management of water.

Fifty years ago the computing capacity of an iPhone required an office building, and a similar transition is underway for water treatment today. IWA participants in Lisbon shared nano-level approaches to reducing risks from bioactive hormones and chemicals in the water system. Some explored, at this level, whether wastewater treatment plants themselves have become potential source points of microplastics. Still others pointed out the potential to manipulate microorganisms at the built/natural interface of water, identifying bacteria and zooplankton to eat the oil in runoff from tar or asphalt paving.

Perhaps the youngest field with the most dramatic potential, and ongoing public concerns, is the use of engineered nanotechnology – the management of matter on a molecular and supra-molecular scale – to absorb and break down water contaminants and pollutants. "We are essentially manipulating ingredients at the atomic or cellular structure of life," said **Pedro Alvarez**, Rice University.

Most attention of nanotechnology has focused on medical applications. Doctors insert nanotechnology into people's veins to cure disease. Now researchers at the lab are pioneering how to harness its energy toward solutions ranging from the personal water-purifying Lifestraw, to aging sewage treatment plants.

The potential for scaling up is enormous, said Alvarez, since nanotech for water treatment and resource recovery translates into: less infrastructure; less material; and less energy requirements. "There's a perception that nanotechnology is too expensive. But the truth is just the opposite. Like 3D printing, the mobile function means it has incredible capacity for point of use, decentralised, and distributed applications at the source."

Nanotech applications could have helped society: after flooding like Hurricane Katrina, or in reuse of fracking water, or to build resilient cities. Rather than construct a multi-million dollar sewage treatment plant, you can get the same results from technology small enough to carry in a suitcase.

Or at least you can, in theory. Yet at this point, "we still don't see too much nanotechnology in practice, due to social and environmental concerns and a negative perception," concedes **Ralf Kagei**, who runs the particle lab at Eawag, Swtizerland. The barriers to adoption are less shortage of capital, or scientific know-how, but of public understanding and acceptance.

Just as genetically modified organisms (GMO) raised public fears, nanotechnology scares people about unknown consequences if nanoparticles break down in the aquatic environment. Science has been playing catch up, and now understands the fate and behaviour of nano-materials. "We can better communicate to the public what we're doing, and how they benefit," said Alvarez. "It's all about trade-offs."

The most disruptive technology innovations take into account of, and then overcome, public barriers.

Crossing Water's Cleantech Chasm

To remove barriers to new water technologies, we must reverse our market approach: don't invent a widget the world requires, then project out; find out exactly what people actually want, then work back.

"Early stage teams need to get out of the lab," said **Frank Rogalla**, Aqualia. "Go talk with end users. You can't just think like a microbiologist. You have to know the business of who you're selling to and what they need." Quite often, the latter approach will produce a radically different value proposition.

The lesson emerged from the IWA Water and CleanTech Forum, a primer at the Lisbon Congress. "Cleantech has reinvented itself as a movement to value waste or reduce energy use," said **Paul O'Callaghan**, BlueTech. "Water has a clear opportunity for both, with strong drivers to do more with less. Climate change won't be mitigated until water and energy are more than ever inextricably linked, and this presents crises and opportunities through 2030."

In defined industries, entrepreneurs like **Hongmei Wu**, Scinor Membrane Technology, China, see a crisis and turn it into an opportunity. Within the desalination industry, she invests in focused research and development, produces energy-saving membrane technology, and exits through a successful acquisition.

But start-up water innovators are quick to tinker, and slow to reach out. Entrepreneurs assume consumers share a sense of techno-optimism until, frustrated, he or she blames utilities as risk-averse gatekeepers.

They may be justified in doing so, since regulatory laws inhibit cost-efficient trial and error. As a utility that understands the bottom line, it still takes us 5-7 years to get from idea to implementation, said **Jonathan Clement,** PWN Technologies. "Still, there is a value proposition in being a pioneer. After all, we are the experts. We can then act as a knowledge centre, and have a 5-7 year head start over competitors."

Assuming there is competition, or markets, or incentives. If necessity is the mother of invention, said O'Callaghan, lack of necessity can smother it. As long as people can turn the tap, get water and sanitation, what's the problem to be solved? In the developing world the need is stronger and demand is greater.

Still, innovation is not just about making money from a single technology brought to market in isolation. "We also must see cleantech holistically, integrating at the systems level," said **Andre Dhawan**, Xylem. "Efficiency can be gained by making components work better, stitching the technology together."

Free advice for innovators who complain about onerous regulation, venture capital, or consumer apathy: Get over it, or get out. "Regulation is like social engineering," said **Sudir Murthy**, Innovations Chief of DC Water. "It can provide huge incentives but also create very large artefacts."

The same applies to subsidies or easy money: that quick boost provides a weak foundation. You don't just want money; you want smart money. And the smartest money, for the best innovations, is built hand in hand with the customer, in a continuous, iterative, responsive process.

Innovation invariably takes more time, costs more money, and requires more customer engagement.

Breaking ‘Out of the Box’

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RECURSOS NATURAIS

Alguns países não dão prioridade ao consumo humano na escassez de água – especialista

20/9/2014, 11:01 113 PARTILHAS

Partilhe

A relatora das Nações Unidas para a água disse hoje que alguns países não dão prioridade às pessoas, em caso de escassez deste recurso.

Uma oportunidade de internacionalização para o setor português da água?

The principles of efficiency, equity, resilience and innovation lay the cornerstones of the IWA Congress. Rising from this foundation was an edifice built on speaking, listening, and sharing stories. People told the water story through words, info-graphics, videos, power-point presentations, and gestures.

Yet the IWA faced a looming Tower of Babel: five thousand people from 109 countries, trained in dozens of professions, struggling to speak one common language. Common means plain-spoken and shared. Some say "the official language of IWA is broken English." **Sarah Tibatemwa**, IWA, heard "a melting pot of Francophone, Lusophone and Anglophone Africans discussing the future of urban water."

Clear communication at the policy/science interface goes beyond the mother tongue. "It's easy to put people together," said **Helena Alegre**, UNESCO. "But to understand each other – that's not so easy. We all work in water but sometimes it seems like we don't speak the same language." For example:

- How does an energy economist, versed in kilowatt hours, talk with a treatment plant scientist, steeped in molecular biochemistry?
- How does a climate statistician schooled in uncertainty explain relative risk scenarios to a utility manager familiar with the jargon of deferred maintenance and budget outlays?
- How does a fisheries ecologist argue against fertiliser subsidies with agricultural officials who face farm lobbyists and election cycles?

Answer: with difficulty.

Yet IWA professionals respond to this challenge by turning outward and

embracing it. **"Our profession does need to change," said Glen Daigger. "That's not a criticism, but a reflection of where we are vs. where we need to be. We need to get bigger not in size but rather in our influence. That means enlist more allies, and become better at speaking outside the water box, not just to each other."**

"To meet expectations and find better solutions to new (and old) water problems," said **Kari Elisabeth Fagernæs**, Oslo Water and Sewarage Works, "it is necessary to think outside of the engineer box, and interact with stakeholders – our users, our customers, different organizations, NGOs, and industry."

The first, quite literal step out of our comfort zones began in the first hour of the first day. "We're here to innovate, to find new opportunities from existing water crises," said **Ger Bergkamp**. "And those solutions don't come from standing still, or talking to ourselves."

Instead, he urged all to shake hands with strangers in front, behind, and across the aisle. Somewhat startled, following nervous laughter, participants and delegates did just that. This new contact likely had different professional training and education. She or he saw water through a different lens and so came at water from a different angle.

Yet at least one common denominator, one reference point helped you share words and worries, to forge a bridge of understanding. You exchanged business cards and, later, a nod of greeting across a crowded lunch or lobby. You compared notes, and came away appreciating the rich nature of the water sector. You invariably found – if not a fast friend or future business partner – a kindred spirit.

In short, *you engaged with an outsider, and in doing so expanded the influence of water.*

Influence through Engagement

Water and funds flowed abundantly during the 'Hydraulic Era' in which water technocrats held enormous influence. With power came responsibility to re-engineer society by re-engineering its water. Professionals moved water over mountains, drained it from swamps, pumped it through millions of kilometers of pipes and sewers, reversed its flow, beat back its spread of cholera, cleaned it up in lakes, and tamed its wild currents behind awe-inspiring dams.

No longer. Professionals can still push the water envelope, but only by permission, and on the cheap.

As customers get monthly bills, politicians look at 3-4 year electoral cycles, and utilities plan 25 year investments, "the days of engineers telling everyone what's good for them, are over," said **Sue Murphy**. "You need to be clear about why you are doing something, like reverse osmosis, then work with the community to get their input on solutions, offering a range of options. We can seem patronizing to customers and community, I still have engineers who I wouldn't let out in public. But other heroes arise when we learn to listen."

Ironically, **water professionals are victims of earlier success. They did just what they set out to do: supplied clean water and sanitation to billions of people, on demand, at little or often no direct charge. The public liked this arrangement: receiving free things you badly need, without asking. Over time both sides took this relationship for granted: water professionals give, the public takes.**

But as water grew scarce, the dynamic changed. Water and sanitation provision resembled other undertakings. The public could have good, fast and cheap services: but now just pick any two.

Change has proven difficult on both sides of the meter. People enjoy powerful sinks, showers, or toilets, but rarely enjoy having to pay for them. Conversely, water professionals like solving myriad technical and natural resource problems; but they don't enjoy dealing with a reluctant, irritated, highly-opinionated public. "To get better at citizen engagement," said **Chris Chesterfield**, Cooperative Research Center for Water Sensitive Cities, Australia. "We face the challenge that push-button, turn-tap systems are such that people don't have to think about them. We need multi-functional teams listening, engaging with them."

If water service costs go up, end users are quick to complain to officials, who respond by blocking rate increases, and thus undermine the institutional integrity of water systems. "We are living in the information age," agreed **Vinicus Benevides**, Brazil, "while we want to succeed, that won't happen if we can't include the customer. They have to become better invested in their role in the water systems. We need to enlarge cooperation in the whole body of water."

To stop breeding public dependency, some argued, we must let go of the old way of 'pushing' out solutions, and shift toward the quiet, more responsive influence of 'pull.'

Effective engagement combines the right message with the right messenger. So while the IWA's efforts to broaden and diversify are welcome, there's room for improvement. "We want to change how the world sees us," said **Silver Mugisha**, of Uganda's National Water and Sewerage Corp. "*New ideas and new institutions require new people. To reflect the world at large we need to change ourselves from within.*"

Communicating Change: Words to Work for Water

The IWA Congress went beyond technology to seek solutions through people. This boils down to communication, which is about words. But words do more than express ideas. They inspire change.

The IWA's goal was that everyone in Lisbon could find at least one person with common interests, and be inspired by at least one new idea to try back home.
"Working in the water sector is actually a very people oriented activity, as nothing will happen without close cooperation, communication and engagement," said **Patricia Bakir**, Jordanian consultant. "Water resources management is the responsibility of everyone, and the more we can learn about all aspects the better."

Water professionals, caught up in the excitement of research, may neglect or underestimate that the most powerful technology in our water management toolkit are words. But words may come out wrong, and jargon can backfire. To influence policy, professionals recognised the need to boil down detail of research into to a clear, concise, compelling message. Used water can honestly be called 'sewage,' 'black,' 'raw,' 're-,' 'pure,' 'treated,' 'reverse osmosis,' or 'new.' To improve branding, learn which works best.

But the messenger matters, too. All too often, the public used ozonation disinfection, eco-san toilets, household water treatment only when researchers were around. Society may adopt technologies only through the skills of social scientists, law makers, IT specialists, journalists and even marketing experts.

Words deployed honestly can inspire democratic outcomes. Yes, water is chronically underfunded. But if professionals engage their customers as advocates, they open deaf ears of elected officials, foundations, and regulators to yield financial, political or even cultural returns on a minimal investment of time.

That's a lesson water professionals glean from our energy sector brethren. One advantage over energy is that water resources are far more direct, visible, universal, tangible, and often more valued by the public.

Two Project Innovation Award-winners in Asia suggest what's possible. Hong Kong had to relocate its Sha Tin Sewage Treatment Works. So rather than face a 'not-in-my-back-yard' backlash, based on fear or confusion, the **Drainage Services Department** engaged the public to find a solution. Its "Experiential, Multi-platform, and Iconic" approach threw open doors, embraced social media and other creative tools, and conducted outreach demonstrations to help people experience the project and internalise the decision.

Singapore's national water agency, **PUB**, has built consensus through straight talk about Four National Taps: catchment water; imported water; desalinated water; and reclaimed or NEWwater. To secure this supply, PUB invested in similar public outreach efforts to reduce future demand from 165 litres per day in 2003 to 140 litres per day by 2030.

In every case, we can't talk to ourselves. We need a more honest, open, active, and transparent public engagement effort, based on clear words that reflect clear thinking.

"We no longer live only in the age of the scientist, the engineer, the computer programmer," said **Inge Wallage**, IWA. "We are entering the age of the philosopher, the age of the poet. Our work in water should reflect that and focus on solutions delivered in a different language."

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