2011-2012

A world of opportunities

working in the international water sector




IWA International Water Association | Young Water Professionals Programme

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IWA Publishing

Introduction

Key issues – an opportunity to help address some of the sector's most pressing challenges

Opportunities – innovation and inspiration in the water sector

Resources

The IWA Young Water Professionals Programme

The IWA YWP Programme is a global network for water sector students and professionals under 35, providing opportunities for career development and sector support.

YWP programme sponsors

Introduction

Providing support for the next generation of Young Water Professionals

The 'World of Opportunities' series acts as a career development tool, providing you with an overview of the wide ranging opportunities in various fields in the water sector, and showcases the profiles of some Young Water Professionals (YWPs) who have already successfully kick-started their careers.

A booklet such as this is useful for a variety of reasons. Its title is quite apt in that it has literally provided a world of opportunities, and has opened doors to careers and studies for many young professionals. It is widely recognised that capacity building and sustainable knowledge transfer are critical global concerns for the water sector. The loss of intellectual assets is a major threat to effective water management, particularly in water-scarce countries where the onus has always been on the scientific community to find technological solutions for sectoral challenges. The repercussions for the sector include high staff turnover as well as the loss of skills and institutional memory in water institutions. YWPs are therefore faced with the threefold challenge of developing their skills, finding mentors to help them do so, and grappling with the added responsibility of re-learning knowledge that could have been retained through sustainable knowledge transfer policies and programmes. The utility of this booklet therefore lies in its ability to succinctly capture what it is that young professionals need to know, where to look for career development information, and whom to ask about such opportunities.

A booklet of this nature also opens YWPs' eyes to the wide range of fields operating in the water sector, and how transdisciplinary the sector is becoming. Indeed, YWPs have a strategic position to play in multi- or even trans-disciplinary environments because we are not, as yet, constrained by the boundaries of our disciplines or sector. After working in and observing trends in the water sector for a few years as a political scientist specialising in transboundary water governance in Africa, I began to realise that new and emerging challenges, such as climate change, eutrophication, acid mine drainage, skills flight and the effects of poverty, urbanisation and social inequality on the water sector, are demanding more integrated levels of ingenuity and expertise from a diverse set of disciplines. Specifically, addressing the governance challenges facing the water sector necessitates expertise from a diverse set of transdisciplinary backgrounds. No amount of technical and scientific ingenuity is adequate if the solutions generated are not relevant, digestible and acceptable to the specific socio-political and socio-economic contexts of our time. Given this realisation, there is growing recognition of the need for more transdisciplinary responses to the challenges facing the water sector. But there are still very few social scientists, economists, or lawyers working on water issues, there are few truly transdisciplinary research initiatives being pursued, and the challenge of creating the space for scientists, government officials and other stakeholders to work together around common areas of concern, remains difficult. Additionally, young social scientists are often unaware of how their skills can be applied, and indeed are needed, in the sector. This booklet therefore provides one way for young professionals and students to learn of the career opportunities in the water sector, how they can apply their seemingly unrelated skills to addressing very real problems in the sector, and how they can build their own capacity.

I would like to take this opportunity then to thank the staff at IWA that painstakingly put this publication together. Their efforts reflect the IWA's commitment to promote capacity building of young professionals, the transfer of knowledge between experienced water professionals and younger professionals, and the development of partnerships, networks and collaborative opportunities between professionals across the world and within the world of water.

By Inga Jacobs, Chair of the IWA YWP Committee 2010-2012

Call me overly gung-ho, but I really do believe that young professionals will play a vital part in facilitating change in the water sector. We are the ones faced with the consequences of the environmental threats, and we are passionate about improving the situation. More than this, we aim to improve the way things are done in a fun and positive way, while still maintaining economic relevance and excellence. And through the IWA's YWP Programme, you can achieve just that and more through the interaction with other YWPs at an early stage in your career, through communication with the many mentors within the IWA community, through the countless networking and career development opportunities at YWP workshops and conferences, and through our various social media platforms including IWA's very own WaterWiki.

I therefore hope you find this great resource to be as helpful as I did, since it was created especially for you, the young professional of today, the architect of our tomorrow…! ■

Land of drought and flooding rain: *international perspectives from Australia*

Australia is a land of climate extremes, suffering years of drought and then devastating floods. **Peter Oliver** from Australia's International WaterCentre highlights the importance of learning from these extremes in order to develop integrated water management for a more resilient and sustainable future.

I love a sunburnt country
A land of sweeping plains
Of ragged mountain ranges
Of drought and flooding rain
Dorothea Mackellar OBE (1885-1967)

Students travel across the continent to Western Australia for a two week field trip to learn from experts at the IWC member university of Western Australia. Credit: International WaterCentre.

The Australian poet Dorothea Mackellar is said to have danced barefoot in the rain – outrageous behaviour for a woman of Victorian times. But like many Australians, living in a land of such water extremes made her appreciate the precarious nature of human existence.

Australia is the driest continent of the world after Antarctica. With its size, topography and location, it experiences a fascinating range of climates and extremely variable weather (Botterill, 2003). It is geologically old and topographically flat, and its average altitude of just 330m makes it the lowest continent in world (Australian Government, 2011). It is situated in poor rainfall latitudes (Kendall, 2010), and the centre of the continent is largely arid or semi-arid, resulting in over 80% of the 21 million population living within 100 kilometres of the coast (Australian Government, 2011), which is double the global average (Stewart, 2005). The El Niño Southern Oscillation in the Pacific Ocean has a large impact on the weather patterns within Australia, causing periods of extreme dryness as well as heavy rainfall (Colls, 1993). This last fact is mirrored in Australian river flows. For example, the Murray and the Hunter Rivers in Australia have ratios of maximum to minimum annual flows of 15.5 and 54.3 respectively, compared to overseas rivers such as the Amazon in Brazil with a ratio of 1.3, and the Potomac in the USA with a ratio of 3.9 (Chartres and Williams, 2006).

Because of these kinds of extremes, and its long history of drought and flooding rain, Australia is a place where young people from all around the world, who are passionate about water, come to explore the issues of water management in both a unique Australian and an international context. One way many choose to do this is through the Master of Integrated Water Management Program at the International WaterCentre (IWC) in Brisbane, Australia, whose staff share Mackellar's passion for Australia, and for water and its significance in Australian landscapes. Living in a country of so many extremes, they see Australia as a valuable platform from which to engage internationally on the integrated water management scene.

Recent floods and droughts

Brisbane itself, where IWC's head office is based, experiences a sub-tropical climate and is situated in South East Queensland, mid-way down the east coast of the continent. The region has a population of 2.7 million people and is the fastest growing region in Australia (Spiller, 2010). The water supply storages, other water sources and treatment plants for this region are networked via 'Grid Twelve', a series of two-way pipes and pumps, which move water across the landscape, taking it to where it is most needed (SEQWater, 2011).

In December 2007 Wivenhoe Dam, the main dam for Brisbane and South East Queensland, was at a critically low 15

IWC students observing dugong feeding trails during a field trip through Moreton Bay seagrass meadows in the one mile harbor of Strabroke island. Credit: International WaterCentre.

percent capacity (Korner, 2010). Level six demand management restrictions (the highest) were put in place, as was a Target 140 media campaign where the community was challenged to reduce per capita consumption to under 140 litres per day (Spiller, 2010). The community responded by exceeding this target.

Australia's other extreme of weather was well exemplified by the January 2011 floods. IWC's Brisbane-based students experienced a very interesting period, that of extreme drought, known as the Millennium Drought (1997 to 2009) (Kendall, 2011), which then led to the devastating 2011 floods. At the same time, IWC's Pacific Island-based students were subjected to a tropical, monsoonal climate, with drier weather in winter followed by summer rains and cyclones. The Australian floods arose from 1 in 500 to 1 in 2000 year rainfall events occurring across the Brisbane River catchment, causing extensive flooding (Sinclair Knight Merz, 2011). They were the subject of intense media reporting and subsequent scrutiny of mitigation and emergency responses.

IWC Masters students benefitted greatly from experiencing these extreme events, and the interactions they had with a wide range of water management practitioners throughout their programme meant they were constantly at the forefront of the learning that happened in that time. The Millennium Drought conditions that preceded the flood led Brisbane to become a leader in water demand management and water reuse technologies, while the aftermath of the floods will bring a new wealth of knowledge to add to Australia's already considerable water management experience.

Water quantity-quality nexus

The scarcity of water, and the subsequent high profile that water has in the Australian consciousness, means that Australians are increasingly becoming aware that water quality is just as important as availability. For example, water sensitive urban design (WSUD) is a growing feature in the Australian urban landscape, as it has been shown to be effective at removing pollution from stormwater runoff and preventing ecological degradation of creeks and coastal waterways (Water by Design, 2011). South East Queensland is also home to world class monitoring and evaluation programmes such as the SEQ Report Card and the Environmental Health Monitoring Program that informs it. The Health-e-Waterways integrated waterways reporting system allows all parties interested in waterway and catchment management to keep up-to-date on stream and catchment health issues in their local area (SEQ Health-e-waterways 2011) (www.health-e-waterways.org).

Albany, Pak Mun and the world

On the opposite side of Australia, The University of Western Australia's Centre for Excellence in Natural Resource Management in Albany offers first-hand knowledge of integrated water management issues in a Mediterranean climate, in both urban and rural settings. On a 14-day field trip IWC students walk farm paddocks extensively damaged by secondary salinisation, they critique remediation strategies, they study the high biodiversity of this unique region, they explore the already evident impacts of climate change on this landscape, and they use all this experience as the basis for a unit of study.

Because integrated water management focuses on water and the way it links landscapes, people, biodiversity and energy, IWC's networks span many disciplines and extend well beyond Australia. And being on the doorstep of Asia and the Pacific, places with myriad water and development issues, and its own indigenous community water issues at home, Australia is a convenient access point for students to study these issues in the places where they are actually occurring.

IWC students have conducted research projects with IWC collaborating organisations throughout Australia, Asia, the Pacific, Africa, Canada, the Americas and the Middle East. They also have the opportunity to study community development in an immersion programme, living and learning from members of the Pak Mun Agricultural Cooperative in Northern Thailand. Led by Monash University anthropologist Dr Bruce Missingham, students spend ten days living with and learning from local villagers about water and community development issues in a monsoon landscape in a developing country.

Australia is a challenging and changing landscape with an equally challenging and changing climate. It is not surprising that it has developed considerable expertise in the integrated management of water. It is indeed a land of drought and flooding rains. It is a land of extremes. It is a land with such a long history of water issues, it is no wonder that Australians sometimes have to dance barefoot in the rain.

The International WaterCentre

The International WaterCentre is a joint venture of The University of Queensland, Griffith University, Monash University and The University of Western Australia. In collaboration with its partner universities, it runs a trans-disciplinary, problem-based suite of postgraduate programmes in integrated water management. www.watercentre.org ■

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PROFILE

Akiça Bahri
Coordinator of the African Water Facility (AWF), African Development Bank Group, Tunisia

Key roles and responsibilities

In my new position I have the responsibilities of improving AWF's operational effectiveness and performance, getting a new strategic plan published and operational procedures approved, managing AWF staff members, and contributing to the better management of AWF's budget. I also have to expand the donor base. Knowledge development and management is also an important activity of AWF. My other responsibilities include increasing the visibility and prominence of AWF and representing it at regional and international meetings and events.

Background

I have an agricultural engineer degree from Ecole Nationale Supérieure d'Agronomie de Toulouse, France, a doctor-engineer from the Institut National Polytechnique de Toulouse, France, and a PhD from the Institute of Science and Technology, Lund University, Sweden.

Career path

I have academic and professional experience in water resources management. I have worked in the fields of agricultural use of marginal quality waters (brackish and wastewater) and sewage sludge, and their impacts on the environment, at the National Research Institute for Agricultural Engineering, Water and Forestry, in my home country of Tunisia from 1977 until 2005. This work was carried out with farmers through field tests and work in the laboratory to arrive at best practices for using the water and sludge available. It also led to directives to farmers for practical application and was translated into policy and legislative issues regarding water reuse and land application of sewage sludge. I was also in charge of research management in the field of agricultural water use and managed, as Director for Research, a research laboratory on use of marginal quality waters, hydraulic and irrigation systems management from 2000 to 2005.

I was a member of the International Water Management Institute's Board of Governors from 2003-2004, a Fulbright Scholar at the University of California at Davis from January-June 2005, and Director for Africa of the International Water Management Institute, a CGIAR (Consultative Group on International Agricultural Research)-supported research institute headquartered in Colombo, Sri Lanka, from September 2005 to May 2010.

I am a member of various international scientific committees: the Scientific Advisory Committee of the International Foundation for Science in Stockholm, Sweden, in the Water Resources research area; the Technical Committee of the Global Water Partnership; and the Scientific Program Committee of the Stockholm Water Symposium. I have also been a member of the Stockholm Water Prize Nominating Committee, and the International Water Association Program Committee.

I have won awards from the Guinness Foundation, the International Foundation for Science, and the Kuwait Foundation for the Advancement of Sciences, and in 2009 received the Professor CNR Rao Prize for Scientific Research.

I was elected a member of the International Water Academy in 2000, a member of the Academy of Sciences for the Developing World in 2003, and the African Academy of Sciences in 2007.

PROFILE

Peter Vanrolleghem
Canada Research Chair in Water Quality Modelling, Full professor modelEAU, Université Laval, Québec City, Canada

Key roles and responsibilities
As a university professor my work consists of the classic three: teaching, research, and service to the community. I am teaching two courses in Université Laval's Bachelor in water engineering, and one course in the Masters of civil engineering. In terms of research I supervise and co-supervise an internationally composed team of about 20 people: four postdocs, two research assistants, ten PhD students and five MSc students. In terms of internal service my main task is the overall responsibility of the water and environment lab of our department. External service is mainly research-related, with PhD jury memberships, scientific review of papers and project proposals, organization of conferences, and of course, my role within IWA as member of the Strategic Council, chairman of the Specialist Group on Systems Analysis and Integrated Assessment, and active member of various IWA Task Groups. Within WEF, the Water Environment Federation, I am vice-chair of MEGA, the Modeling Expert Group of the Americas, and at the Canadian level I am vice-president of the Canadian Association on Water Quality. In these capacities I try to be a bridge between IWA and these North-American professional organizations.

I am lucky that my work is my hobby: I love to be creative and interact with young people with different backgrounds, coming from different regions in the world (the countries represented in modelEAU include China, Venezuela, Spain, Madagascar, France, Canada, Switzerland, Iran and Tunisia). One of my key roles and responsibilities is to create the environment in which people are enthused to collaborate day in day out.

Background and career path
Many people think I am a mathematician by training, but I have a degree in bioengineering, with a specialisation in industrial microbiology. After my graduation at Ghent University in Belgium I conducted my first years of research at the Katholieke Universiteit Leuven (also in Belgium), where I learned about modelling through the quantitative study of microbial cultures producing antibiotics. For my PhD I returned to Ghent University where I worked on activated sludge modelling and how respirometry could support this.

After a postdoc at Delft University of Technology, I got a professorship position at Ghent University where I started the BIOMATH research team. This group became specialised in modelling a wide variety of systems in which bioprocesses play a role: fermentation, chocolate production, ecological farming, wastewater treatment, river basin management, and so on. The challenge for me in joining such widespread projects was to get the background of the application field, to get insight into the problem and to be able to find the most appropriate modelling tools to tackle it. It was very stimulating to learn a wide variety of things from the domain specialists and observe that the modelling tools could often quite easily be transposed from one discipline to another.

After ten years at BIOMATH, my wife and I decided to leave busy Belgium and move to spacious Canada. The new water engineering programme opened opportunities for me and I was very happy to be nominated Canada Research Chair in Water Quality Modelling in 2006. I immediately started a new research team that we called modelEAU. Our research is methodological in nature, i.e. we develop modelling methods and procedures that can be applied in a wide range of water related studies, in wastewater treatment plants, sewers and rivers, that are exposed to problems of nutrient enrichment and micropollutants, and in which energy and other resource use and greenhouse gas emissions should be minimized. The methods we focus on are the efficient collection of water quality data, the automated evaluation of the quality of these data, the development of new models and new procedures to build them efficiently, the use of models to optimize the system by better design or use of process control, and software development that supports modelling water systems and that allows evaluating data quality.

It has been a true pleasure to integrate into a new country, into a new group of stimulating colleagues, to join a new network of water professionals and be successful in starting a new research team from scratch.

The changing face of the sanitation sector professional

2.4 billion people still lack basic sanitation and the majority of wastewater is discharged into the environment without any form of treatment. **Jonathan Parkinson**, Programmes Manager at IWA, and **Darren Saywell**, Regional Group and Programmes Director at IWA, provide an overview of the need to find sustainable solutions to meet the world's sanitation challenges.

Traditionally, the sanitation sector has been staffed by public health and environmental engineers who apply their skills and expertise to construct sanitation systems which are designed to improve public health and reduce pollution of the environment. Conventional systems excreta and wastewater disposal generally consist of reticulated sewerage connected to various types of treatment process. Although the design of these systems may not appear to be so challenging compared with other forms of infrastructure that have higher professional standing and prestige, solutions for urban sanitation are becoming increasing ambitious and important. Take for example Thames Water's London Tideway sewerage scheme in the UK, which involves the construction of a 32km pipeline, almost as long and just as wide as the Channel Tunnel between the UK and France. Or, proposals for high-tech wastewater treatment schemes to meet rising demands for water reuse for irrigation, industrial reuse or even to produce potable drinking water from sewage.

A polluted pond in Faisalabad, Pakistan. Low-lying land becomes the location for discharge of wastewater effluents which subsequently needs to be pumped out. Credit: J Parkinson.

Sanitation – a multi-disciplinary profession

There is a increasing need to design sanitation systems that have multi-dimensional benefits. Through innovation and creative design, projects can satisfy demands for water, promote the amenity value of water and energy recovery, as well as meet the conventional objectives of pollution mitigation. These schemes require competent, trained engineers with a high degree of technical engineering expertise, but in addition, they require an understanding of the wider benefits related to the social and economic value of alternative technological solutions to society and the environment. In addition to traditional technical competences, contemporary environmental engineers therefore need to have a much broader perspective and ability to assess the social and environmental benefits of his / her work in economic terms.

Decentralised wastewater management

Although large-scale centralised solutions for wastewater disposal are important, these alone are unlikely to solve the World's sanitation problems. There is increasing recognition that large-scale centralised systems based on waterborne sewerage are only suited for dense urban centres and are therefore a partial response towards tackling this global problem. The scale of the challenge is immense. Few cities in the world have sewerage networks that connect more than 10% of the population and, according to UN Water (the coordinating body for those United Nations agencies working on water issues), an estimated 90% of all wastewater in developing countries is discharged untreated directly into rivers, lakes or the oceans (UN Water, 2008). In response to this challenge, there is an increasing focus and acceptance on decentralised wastewater management systems. These systems rely on smaller-scale treatment units (DEWATS) such as baffled anaerobic tanks and filters and constructed wetlands that function without the need for extensive mechanical machinery or a power source to operate pumping equipment.

Meeting the sanitation needs of cities in developing countries

Wastewater assets are a huge investment, but the benefits are significant. Such investments allow high population densities to live in relatively disease-free and clean environments, which are essential for the wellbeing of urban dwellers, and help to support their productivity and wider economic development. Without doubt, in the absence of the expertise of environmental engineers, life in cities would be very different. A life without these assets is unthinkable for many people living in the industrialised world. But for those who reside in the developing world, the day-to-day implications are all too familiar. There are many examples of cities where a connection to a functional sewerage network is only for the privileged minority. In fact, an organised system for collection and disposal of human waste and wastewater is lacking in most cities throughout the world.

Whilst there are often political aspirations to have 100% sewerage coverage using conventional technologies in large cities, the reality is that this approach is unrealistic for many communities in the short- to medium-term. However, there are signs of hope. The sanitation sector is developing rapidly to accommodate recent advances in technology and more creative approaches for management of servicing of on-site sanitation (desludging) and the use of lower cost sewerage technologies such as condominial sewerage and smaller scale treatment systems – many of which aim to provide opportunities for reuse, either through biogas generation or recycling of nutrients through the application of ecological sanitation systems.

Ecological sanitation

Modern agricultural farming practices are highly dependent upon the continual application of synthetic fertiliser to support crop production. Fertiliser production is dependent upon the mining and

Open drain in Nam Dinh, Vietnam. Open drains designed for drainage of stormwater are frequently heavily polluted by wastewater effluents. Credit: J Parkinson.

processing of the mineral phosphorus, but these resources are limited. Demands from agriculture resulting in escalating costs of manufactured fertiliser, combined with the accumulation of phosphorus in the aquatic environment, has led to increasing concerns about the sustainability of current sanitation systems and a focus on ecological sanitation (ecosan). These are systems that use less water, enable the reuse and recycling of resources in excreta and wastewater and use less energy (or produce energy via the production of biogas). It is envisaged that there will be increasing demands for sanitation professionals who can implement sanitation systems that respond to these demands.

The need for engineers with a 'softer touch'

A decentralised approach that responds to community demands and involves local stakeholders in the planning and design of sanitation systems, requires experts with core competences in engineering. But increasingly also with the skill to look at a wider range of sanitation and treatment technologies tailored to meet local stakeholder needs, willingness to pay and availability of management capacities. Sanitation sector professionals need to be able to design projects that meet demands and one of the key foci of sanitation projects is therefore engagement with local stakeholders. Although very different from the scheme cited above in London, there is a need in virtually all situations for some level of stakeholder consultation. Sanitation sector professionals therefore need to understand a broader set of issues and often conflicting political priorities that influence development in a wider context. For engineers, this means a willingness and ability to communicate effectively and work in close partnership with local authorities, representatives from civil society, non-governmental organisations (NGOs), and the private sector to develop workable systems that provide the level of service that customers require, and are sustainable from a financial and operational perspective.

Human resource development in the sector

These are exciting times in the world of sanitation. There have been significant and sustained advances in many areas, including increasing political ambition and priority for sanitation projects, and improved financial resourcing for the sector. There is also a more diverse and creative community of research and practice to help develop and implement appropriate solutions at scale. However, there remains a huge need to produce many more trained sector specialists to be able to meet the backlog of sanitation needs. Capacity constraints are one of the main reasons that the sanitation-related Millennium Development Goal (MDG) target is one of the poorest performing of all the MDG targets.

In relation to this, a recent study supported by the UK's Department for International Development (DFID) assessed human resources development requirements in the drinking water, sanitation and hygiene promotion (WASH) sectors in five countries (Bangladesh, Timor Leste, Mali, South Africa and Zambia). The study focused on identifying shortages and gaps where public sector institutions, NGOs and private companies are involved in provision of water and sanitation services.

The study showed that the supply of qualified staff entering the workforce is insufficient for various reasons. These are identified to be related to various issues, but one of the key issues highlighted by the study was that related to the quality of the training. Qualified staff often lack important competences needed for working in the WASH sector. As well as outdated curricula, standards of teaching can be linked to poor incentives within training institutions due to low salaries and a general lack of resources. Additional funding is needed for universities, colleges and other training institutions to enable them to upgrade the quality of their educational activities. There is also a need for more opportunities for graduate students to acquire practical work experience. As well as improving the curricula on university training programmes to prepare graduates for work in the sanitation sector, there is a real need for more short-term vocational courses and on-the-job training. As part of this, engineers and technically-orientated staff require training to develop essential skills and competencies in community-based sanitation and hygiene promotion, as well as other areas.

The study also observed clear gendered occupational boundaries, with men working more on water supply and women more on hygiene and sanitation promotion. There is a low level of women graduates from universities, especially from technically-orientated courses. The low representation of women in technical and managerial positions can be linked to a failure to promote careers in the sector to younger women and a lack of policy

incentives to recruit more women. For women to play a more significant role in meeting predicted future demands for WASH sector workers, it is clear that more women should be encouraged to gain technical qualifications and employers' preferences should be reshaped to ensure that women participate in the labour market on more equal terms.

Searching for the right people

The need for a professional cadre of individuals who can drive the sanitation agenda remains fundamental to achieving the challenges outlined above. Typically, successful sanitation projects and programmes are characterised by certain commonalities – a longer-term staff commitment, with individuals that possess the right skills mix to 'sell' sanitation. Such individuals may be found in a range of institutional settings, including the private sector, NGOs, and at all levels of government. The required skills mix is both technical, but perhaps more importantly, related to behaviour change and marketing.

Given the current trend for public sector down-sizing, it seems likely that these cadres will increasingly be sourced from beyond the realm of government. Two prominent exceptions may remain – technician-managers in urban utilities who remain key to urban sanitation service delivery, and health specialists or other extension workers who support long-term behavioural change. For these professionals, the critical issue is less about retraining and more identifying the right institutional incentives so that working on sanitation brings with it clear institutional level rewards. Re-aligning institutional incentives and building professional cadres are related – the time-lag between the adoption of, for example, the concept of appropriate use of technology (the early 1980s) to its current status of 'received wisdom' highlights the possibilities and timeline required to amplify change in professional practice.

Stepping beyond the realm of government there are people in small businesses, or who work as masons and plumbers, who have a key role to play. In these cases, tailored training programmes, help in developing business acumen, or research to identify market niches for product development, can help transform the capacity of a sector to respond. Therefore, there is a strong demand for personnel with a strong business acumen to be able to design and manage financially sustainable sanitation services, which meet demands for improvements.

End note

Sanitation is a global problem requiring highly committed professionals with a passion for applying their engineering skills towards a common good of improved public and environmental health. It is not always seen to be the most prestigious of professions. For some engineers, the implementation of sanitation systems may not appear as exciting as the design for a bridge or multi-storey building. It is also not the most highly paid of professions – not compared with lawyers or bankers for example. But career opportunities in the sanitation sector are diverse and highly rewarding. One of the most exciting aspects is the multi-dimensional aspects of the work. As well as the engineer, sanitation projects require inputs from a broad range of disciplines – including economists, gender and institutional specialists, social development workers, and so on. Opportunities often arise for overseas travel and work placements, which are highly formative in terms of professional career development as well as developing a broader awareness of political and cultural issues. In addition, those that choose to work in the sector achieve a strong sense of being part of an international community of specialists committed towards improving the quality of the environment and the lives of those that currently lack adequate sanitation. ■

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PROFILE

Rashmi Chand
Process Engineer, Jacobs, UK

Key roles and responsibilities

I am currently involved with Scottish Water Solutions projects of Scottish Water. As a process engineer, I am responsible for Capital Maintenance and Design projects for different water / wastewater treatment works in Scotland.

Background

I was awarded a PhD for a thesis titled 'Advanced oxidative wastewater treatment using cavitational reactors' from the University of Abertay in Dundee, UK, in 2008. I completed my undergraduate and post-graduate studies at Delhi University and Banaras Hindu University in India.

Career path

Water and environment has always been my passion since my days at university!

I studied environmental sciences at post-graduate level and undertook summer training in groundwater pollution at the National Environmental Engineering Research Institute (NEERI) in Nagpur, India, and did my dissertation on environmental management system at Tata Iron and Steel Co (Works) in Jamshedpur, India. I have published and presented various scientific papers in peer reviewed journals and national and international conferences, from work undertaken during my PhD. In 2009 I was awarded the Willy Masschelein Award for the Best PhD Thesis at the IOA World Congress in Tokyo by the International Ozone Association. As an active IWA Young Water Professional (YWP) in the UK, I have participated as presenter, reviewer, chair and co-organiser (YWP 2011) in every UK IWA YWP conference since 2006. In the last two and a half years of my professional career at Jacobs Engineering UK Ltd, I have been involved with various water and wastewater projects with Scottish Water CID and Solutions. At the Jacobs office in Glasgow, I am also H&S and Sustainability Champion!

I aim to compliment my PhD degree and process engineering experience with a corporate management degree to link the technical knowledge with business strategies.

PROFILE

Åse Johannessen

Position
I wear a couple of different hats for the moment. Mostly I am focusing on finalising my PhD at Stockholm University, Sweden, looking at social learning processes which respond to perceived water-related risks and build resilience in urban planning and ecosystem management.

Key roles and responsibilities
I work on case studies mainly from Sweden and Mozambique. I am right now excited about an action research project (SPLASH) we have started in Mozambique (coordinated by IWA), studying innovative learning mechanisms to meet risks of sanitation in a flood prone environment. At the same time I am the cluster lead for the Water and Disaster Risk Reduction cluster group at Swedish Water House / Stockholm International Water Institute (SIWI), facilitating a dialogue on policy and practice with Swedish actors working in disaster risk reduction. I am also co-lead in the working group for sustainable sanitation in emergencies under the SuSanA network.

Background
I have a Masters in biology from the Stockholm University, with a specialisation in systems ecology and water. I am focusing now more on social science and management issues in my PhD, looking at strategic innovative capacity, organisational learning and adaptive governance.

Career path
In Stockholm I worked at an archaeological research laboratory, analysing findings with advanced laboratory equipment. We also did excavations in the field. I then decided on university studies in biology, including geology and geography. After field work climbing trees in Ecuador's cloud forests for my Master thesis I experienced a different world and was very affected by the poverty I saw, and the natural resource issues fascinated me. A milestone lecture by SIWI's Malin Falkenmark opened my eyes also to global water and environment issues. As I was waiting for a PhD position at the Department of Systems Ecology, working on my current

subject, I worked as a project manager for the Stockholm Junior Water Prize, and also as an author of UN Habitat educational material for African water classrooms. We also produced water educational material for teachers in Sweden as we felt that the curricula did not keep up with recent and global issues.

For private reasons I left my PhD studies after three years and moved to London. There I was lucky enough to get a job at Defra (UK Department for Environment, Food and Rural Affairs) in the water department, working with water policy development. I was also briefly working as a consultant on various water and environment issues. I jumped on the opportunity of working for the International Union for the Conservation of Nature in a local government office in Botswana, giving technical support to integrated ecosystem management in the Okavango and the regional water programme in Southern Africa for two years. I was then headhunted to IWA, working for three years mainly with the Development, Disaster Risk and Climate Change Programmes.

Researching the link between diet, water and nutrients

There is a complex set of interactions between agriculture, water and nutrients, and with populations increasing every day, we need to understand how each influences the others. Here, **Simon Thaler**, a Project Assistant at the Vienna University of Technology in Austria, outlines research undertaken in Austria into how changes to diet and agricultural practice can lead to a healthier environment.

Agriculture and water are two sides of the same coin. On the one hand, water is essential to sustain and reach high yields in agricultural production. About 1000m³/capita. year are used for the food production of an average diet (FAO, 2003). Thus, the predicted population increase will have significant impacts on agricultural water demand and supply. On the other hand, the diffuse pollution of water with nutrients from agricultural production is well known. Eutrophication of rivers and the sea is caused by intensive agriculture.

In recent years, several alternatives have been discussed to solve the conflict between agriculture and water. One idea is a diet change from a heavily meat-based diet (in developed countries) to a healthier plant-based diet with reduced consumption of animal products. It is a fact that the production of meat and meat products consumes more resources than the production of plant-based food. Thus, a vegetarian diet spares our resources and is considered to be environmentally friendly. In addition, a balanced diet is recommended by nutritional experts to ensure a healthy state of the society. So, why not combine the positive effects of a healthy diet? An Austrian research team consisting of experts from the fields of water, agriculture, nutrition and energy tried to answer the question: 'What will happen if a balanced diet was applied for a whole country like Austria?' The impacts of a diet change on water and resources are summarized below.

The basis for all calculations is a complete inventory analysis of agricultural products, fertilizers and the relevant imported and exported goods to determine the current state of diet in Austria. This is then used as the reference system for further investigations. A change in diet habits was predicted to influence agricultural production and several other processes described in the reference system.

Area usage and demand

On average, an inhabitant of Austria consumes an area of 3600m² for nutritional purposes, whereas only 600m² are used for the production of plant-based food (see Figure 1). The remaining 3000m² are necessary for the production of animal-based food. To provide the same amount of calories, animal-based food needs 7.5 times more space than plant-based food. As various goods are imported to and exported from Austria, those imports and exports were converted into a 'virtual' area as well. In total, 421m²/capita of arable land are imported via plant products and 440m²/capita of grassland are exported as beef and milk (see Figure 2). Although Austria has enough agricultural space, the share between arable and grassland is not equal, which is the reason for the import of protein foodstuff (soya). Thus, in the reference state, self-sufficient food production is impossible in Austria.

By applying a balanced diet as recommended by the German nutrition agency Deutsche Gesellschaft für Ernährung (DGE) (2008), self-sufficiency would become feasible. In general, an approximately 50% reduction of the consumed meat and meat products is required to fulfill the needs for a balanced diet. In contrast, the intake of cereals, vegetable and fruit must increase. If nutritional habits in Austria switched to a balanced diet, only 2600m²/inhabitant were used for the supply of food. Hence the demand of area would decrease by 30%. The share of fodder production would be reduced, while the cultivation of cereals, vegetables and fruits would consume more space.

Nutrient emissions into surface waters

A detailed mass flow balance for nitrogen and phosphorus was performed to gain knowledge of resource consumption and emissions (losses) to the atmosphere and waters as a consequence of the nutritional habits. For the calculation of emissions into groundwater and rivers the nutrient model MONERIS (Behrendt et al., 1999) was used as described in Schilling et al. (2011). For the reference state 8.5 kg nitrogen/(cap.yr) are transported out of the country by Austrian rivers (mainly the Danube). A balanced diet would decrease this export by 15% and cause positive effects in the Black Sea as the receiving

Flooding of the Danube in Budapest, Hungary. Austria and Hungary are amongst the ten countries which the river flows through or borders. Credit: János Fehér.

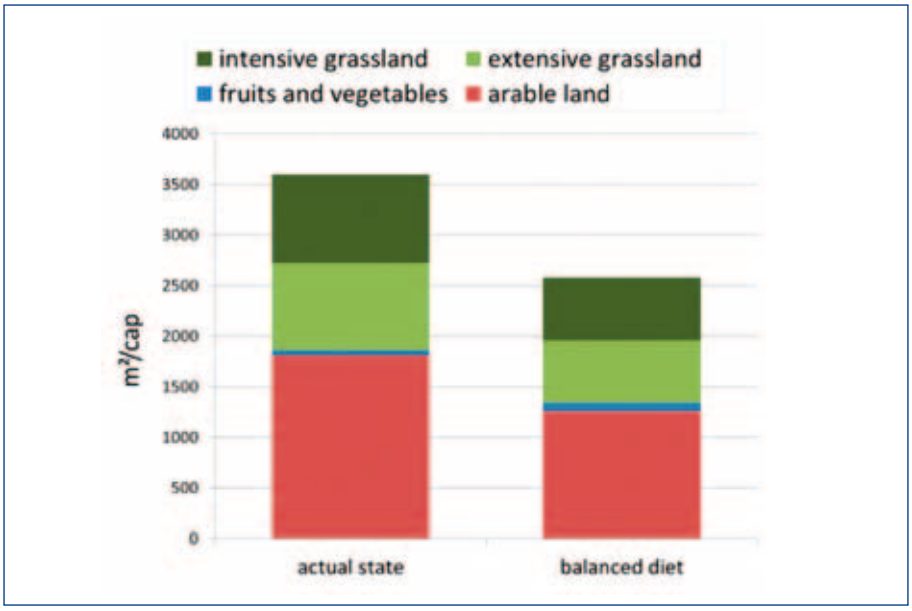

Figure 1: Area demand for an actual and a balanced diet divided between animal- and plant-based food

water of the Danube. The reduction in phosphorus emissions amounts to only 5%. Thus, other management options, such as erosion protection, seem to be more efficient for a reduction of phosphorus emissions into surface waters.

Assuming a balanced diet not only in Austria, but also in its neighbouring countries, the export of nitrogen would further decrease to a maximum of 21%. The reason for this additional reduction is the transboundary transport of air pollutants, and furthermore the deposition of reactive nitrogen. Thus, a shift to a balanced diet in Austria and its neighbouring countries is necessary to maximize the benefits of diet change.

Water demand

Austria is fortunate enough to have no limitations in water availability in general, although there are some dry areas on a regional scale. Still, only a small amount of the agricultural area is irrigated, as most of the water demand in agricultural production is supplied by rainwater. Thus, a diet change would not drastically affect Austria's water demand in agriculture. The application of the water footprint demonstrated a decrease in the green water (precipitation water stored in soils and used by the plants) in the same range as the decrease in the agricultural areas. Blue water (irrigation water evapotranspirated) would roughly remain the same. Nevertheless, a change in diet could be of major

PROFILE

Cassilda Teixeira de Carvalho
Technical Assessor, COPASA – State Utility Water and Sewage Company of Minas Gerais, Brazil

Position

Since 2003 I have been a Technical Assessor to the President of COPASA, the State Utilitiy Water and Sewage Company of Minas Gerais. COPASA is one of the largest and most developed companies in Brazil, serving 12 million people and 613 municipalities.

Key roles and responsibilities

Among my many responsibilities I am in charge of institutional development and business performance evaluation, not only in Brazil, but also abroad. COPASA has its stocks in open market shares, and I am constantly in search of new opportunities and business to set up the company in the international marketplace. COPASA has a large number of projects outside Brazil, and it is my responsibility to follow and propose new strategies.

Background

I graduated in 1979 as a civil engineer from the Federal University of Minas Gerais, and earned my masters degree in sanitary, environmental and water resources engineering at the same university.

Career path

I have worked for COPASA since 1979, executing technical functions in the areas of water and wastewater systems design, construction and operation, as well as the planning and implementation of water and wastewater for rural areas.

After so many years working in the sanitation sector in Brazil, I extended my activities into other countries, and up to last year I represented America on IWA's Board of Directors. As President of ABES, the Brazilian Association for Sanitary and Environmental Engineering, I represent Brazil in other international organizations, such as AIDIS (The Interamerican Association for Sanitary and Environmental Engineering), AWWA (American Water Works Association) and WEF (Water Environment Federation). ABES is the largest non-profit organization in Brazil, representing approximately 10,000 associates all over the country. ABES traditionally contributes to and influences strategies and the establishment of policies for the sanitation sector in the country.

ABES runs every year a Business Excellence Management Award (PNQS) which, along with management practices, evaluates water and wastewater companies or business units results in a benchmarking fashion across six areas – financial, customers and markets, society, people, process and suppliers. 40-45% of the total possible score is determined by results achieved by the organisation. For each area there is a set of mandatory performance indicators to be monitored according to a special orientation guide – GRMD. Using self assessment and peer review, and by applying best practices, organisations develop their objectives and act in a more competitive manner.

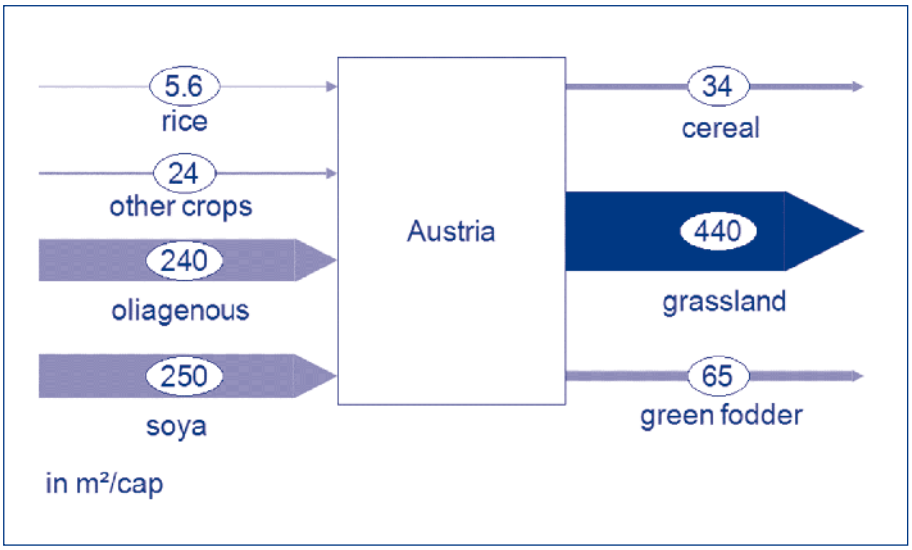

Figure 2: 'Virtual' agricultural area imported and exported via agricultural products

importance in countries with stressed water resources.

Nutrient resource consumption

Nitrogen and phosphorus are main nutrients required for plant growth. Nitrogen is synthesized out of the atmosphere, whilst phosphorus is mined and limited in terms of easy attainable ores. Hence, the careful use of these resources is economically and environmentally feasible. A diet change would reduce the demand of nitrogen (fertilizer, foodstuff and other biomass) and phosphorus by 37% and 27%, respectively.

Summary

A vegetarian diet is definitely better for the environment than a carnivorous diet. To fight diet related diseases a balanced diet between plant-based and animal-based food is postulated by nutritionists. To investigate and quantify the implications of a balanced diet applied in Austria on agriculture and the environment, a research project was carried out and came up with the following conclusions:

Even a balanced diet has huge benefits compared to the actual nutrition habits. 30% less area is necessary. Furthermore, the nitrogen and phosphorus export through rivers decreases by 15% and 5%, respectively.

While the agricultural water demand is of minor importance in Austria and is hardly influenced by a diet change, this might be of higher importance for countries struggling with water scarcity.

Applying a balanced diet change would result in lower nutrient resource input, which is especially relevant for the limited resource phosphorus.

Finally, a balanced diet would contribute to a healthier society and reduce the costs spent for public health care.

The introduced research was funded in the frame of the proVISION programme. More information can be found on the project homepage http://iwr.tuwien.ac.at/wasser/projektseiten/gern.html ■

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PROFILE

Min Yang
Professor and Director, Chinese Academy of Sciences, China

Profile

I am Professor and Director of the State Key Lab. of Environmental Aquatic Chemistry at the Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, in Beijing, China.

Key roles and responsibilities

I am responsible for managing the State Key Lab. of Environmental Aquatic Chemistry, a prestigious laboratory in the water science and technology field in China. As well as this I have to take care of my own research group by sourcing research projects and supervising young researchers and PhD / Master students in my group. I am also involved with various governmental and industrial consulting activities.

Background

I graduated as an environmental engineering student in the East Chinese University of Science and Technology in 1985, and acquired my master and PhD degrees from Hiroshima University, Japan, in 1989 and 1992. I then worked in a water engineering company in Japan as a researcher for over six years before I moved back to China. In Japan I mainly worked on technology development for industrial wastewater treatment. In my present position I mainly focus on the identification, fate and removal of emerging pollutants in drinking water, and municipal and industrial wastewater.

‘Cities of the future’: engineering to deliver innovation in urban infrastructure

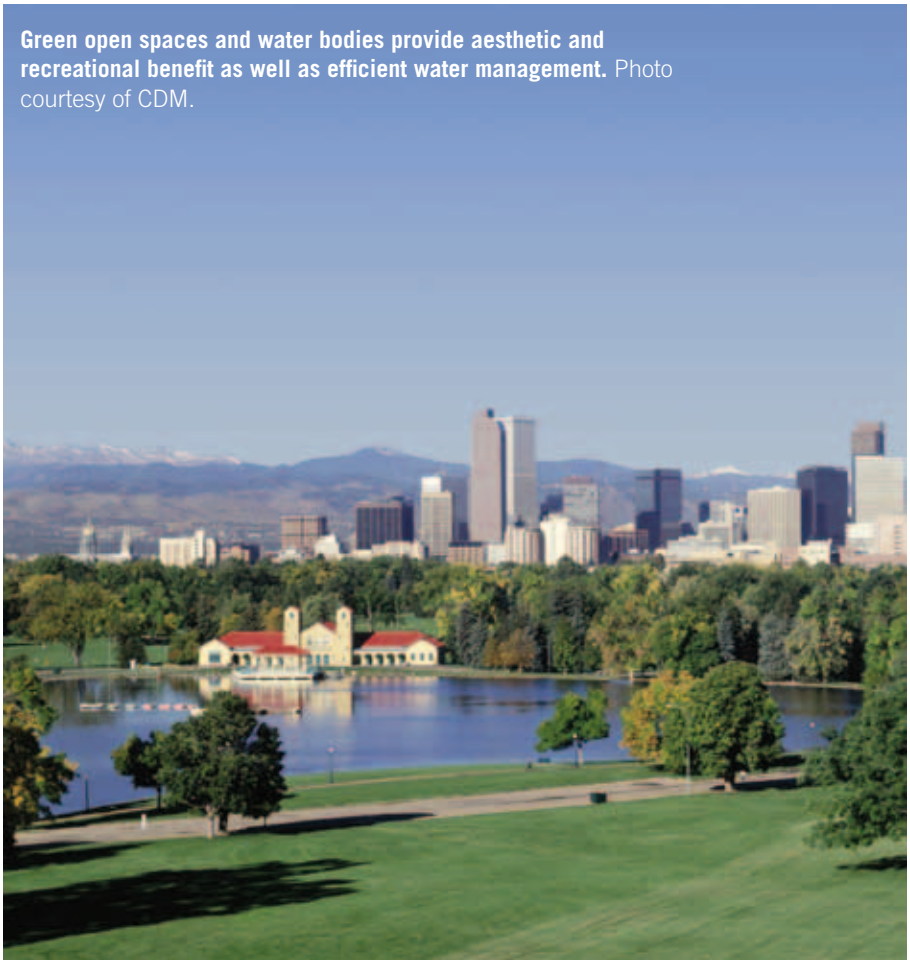
As the urban landscape expands, so does the challenge of urban water management and planning. **Paul Brown**, Executive Vice President of CDM, looks at the integration of sustainable use and transport of water into a city setting.

For those of us working in water management there is a powerful confluence of challenges and opportunities, of advancing technologies and new approaches that drive a sense of the timeliness, possibilities, and importance of our profession.

The challenges stem from the accelerating urbanization of our planet, the rapidly increasing exploitation of natural resources, and the threats posed by climate change and continued environmental degradation. Plenty has already been written about these challenges.

At the same time, the opportunities offer reason for optimism. Advancing technologies are giving us new ways to treat water from all sources, to recycle it, and to control its effects on urban environments, enriching our cities and strengthening their economies.

Just as important as advances in technology, there is an on-going revolution in thinking about approaches to urban water management and planning. New principles have taken root across many geopolitical boundaries. We have recognized that achieving sustainability in an urban setting requires integrated infrastructure and resources planning unlike any we have accomplished in our long history.



Green open spaces and water bodies provide aesthetic and recreational benefit as well as efficient water management. Photo courtesy of CDM.

Increasingly there is awareness of the central role that water resources and water infrastructure can play in advancing the sustainability goals of integrated social, economic, and environmental improvement.

The water professional has much to do to realize the centrality of this role. Our understanding of aquatic ecosystems, our knowledge of how land use affects water quality and quantity in urban watersheds, and our growing appreciation of the issues of sustainability, the impacts of climate change, and the need for equity in community planning – these are all areas where water professionals can bring value to the process of delivering tomorrow’s urban infrastructure.

What do we mean – ‘cities of the future’?

As my colleague Vladimir Novotny has pointed out, we are moving to a new paradigm of water management. Historically, we have tended to view water either as a resource to be used for potable, commercial, and waste disposal purposes, or as a nuisance and threat to be protected against. Centuries of engineered systems have been designed to move water rapidly from where it is to where it is needed, and from where it is not wanted to someplace else. The cost of these systems has increased dramatically and, in many cases, the benefits they produce are diminishing in kind.

Future progress will require fully coordinated management of water and land in a manner that has few precedents. Instead of systems that provide water, sewer, and drainage to individual parcels of land, we will be designing urban landscapes that use integrated systems of plumbing and land use to reduce

Future concepts for water infrastructure will take a complete view of the urban hydrologic cycle and the water mass balance within cities. Photo courtesy of CDM.

the need for more pipes, pumps, and treatment plants, as well as the imported water to fill them. Design objectives will be different as well – transitioning from the use of natural resources to fuel urban development towards managing urban development in ways that preserve natural systems for growth and renewal.

Future concepts of the purpose and function of water-related infrastructure will be based on a complete view of the urban hydrologic cycle and the water mass balance within cities, viewing all the components of water supply, stormwater, and wastewater as part of a closed loop.

We will incorporate landscape changes including less imperviousness with more green space used as buffers and for groundwater recharge. We will help restore the landscape's hydrological and ecological functions. We will rely on greatly enhanced removal of organic chemicals, nutrients and endocrine disruptors from effluents and promote the application of best management practices that provide treatment, water conservation, and storage of excess precipitation for reuse.

One of our goals will be to design an urban landscape that mimics the processes and structures present in a pre-development natural system, sometimes called performative landscape. The urban landscape of the future will be based on storage-oriented drainage with less reliance on underground conduits and more surface storage, infiltration and flow retardation.

Closing the water loop will drive decentralization of some components of the urban water cycle in contrast to the current highly centralized regional systems employing long distance water and wastewater transfers.

None of these identified 'new ways of thinking' comes to us brand new. We have seen greater focus, political will, and philosophical consensus that will influence the work we do over many years to come.

The shape of future cities

The trends identified above apply as well to programmes of urban rehabilitation as they do to the full conceptualisation of greenfield 'eco-cities'. Each project that helps to create sustainable urban environments delivers value on its own merits and at the same time helps to build and improve the model and array of concepts on which such sustainable systems can be developed for wider application.

If we accomplish this new vision what will our cities look like, and how will they function? Imagine a city where:
People live and work in relative harmony with their natural and built surroundings as an integrated economic, environmental, and social unit.

Individual, pedestrian 'villages' help to define communities of human scale and distinct character.

Transportation patterns make it easy for residents to reach their destinations on foot or by public transport systems fuelled by clean technologies.

Renewable energy sources such as wind, solar, bio-fuel and recycled city waste help support a carbon-neutral environment. Housing and workspaces are of energy efficient design.

Residents are always near green open spaces and water bodies that provide aesthetic and recreational benefits as well as efficient water management. These interconnected green spaces provide habitat for desirable flora and fauna, ensure infiltration and storage of excess water, and buffer the waterways from pollutant loadings.

The urban environment is water-sensitive. Permeable hardscape and extensive plantings and green areas capture and retain water; the water is available for extraction, treatment, and use. Rainwater harvesting and recycling means that larger buildings can meet many of their own water needs.

Waste is recycled; organic wastes are composted and applied to farmland for nutrient value and tilth. Other wastes can be converted to bio-energy.

The citizens understand and appreciate the balanced, 'triple-bottom-line' concepts of sustainability; they educate themselves and each other on sustainable practices, and reinforce the principles of balance and harmony and conservation.

All this is a challenging and demanding proposition. As the product is new, so is the process. The integrated chemistry of tomorrow's urban infrastructure can be achieved only through integrated development, undertaken by interdisciplinary teams, partnerships of public and commercial and social interests, and drawing on extensive community engagement. As we look towards more coordinated management of infrastructure and natural resources, we will need to better understand the complex relationships underlying our urban systems and the communities and businesses that depend upon them. This represents a new world of exploration and discovery.

Where in the past we have dealt with

Advancing technologies give us new ways to treat water from all sources, to recycle it, to control its effects on urban environments. Photo courtesy of CDM.

largely reactive planning and engineering to meet water needs, in the future we will be participating as a peer in the integrated planning of urban systems. We will bring to the urban conversation our deep understanding of the importance of the urban watershed in overall urban planning. Surely, our work will encompass all of the modelling and engineering capacity we have traditionally brought to urban infrastructure. Now it will be informed as well with other features of sustainable design and innovations of technology and behaviour that we have not yet imagined.

If ever there was a time for water professionals to step forward and contribute to our understanding of what 'sustainability' in urban infrastructure means, now is it.

And if ever there was a time when water professionals should look forward on their careers as vital, exciting, and necessary to creating the future, that moment is before us as well. ■

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Acknowledgement

This article is adapted from several publications and presentations made by Mr Brown, including the Preface and Chapter One of Cities of the Future: Towards integrated sustainable water and landscape management, edited by Vladimir Novotny and Paul Brown, IWA Publishing, 2007, and the Thomas R Camp lecture 'Water resources and land use: creating sustainable cities of the future', sponsored by the Boston Society of Civil Engineers Section, American Society of Civil Engineers, December 2007.

PROFILE

Clàudia Turon Planella
Manager of the Research, Development and Innovation (R&D&I) Department and the International Department of Sanejament Intel·ligent S.L., Spain

Position

Since June 2009 I have been Manager of the R&D&I Department and the International Department of Sanejament Intel·ligent S.L. (SISLtech; www.sisltech.net), a tech-based PYME (small and medium enterprise) specialized in the design, development and implementation of advanced control systems and intelligent decision support systems within the water and energy framework.

Key roles and responsibilities

Under the position of R&D&I Department Manager, I undertake the technological surveillance of new developments and emerging necessities of the water and energy sectors.
I lead the R&D&I projects: searching for partners and financial support; coordinating proposals preparation; and partially executing and supervising projects.

My responsibilities as International Department Manager are: looking for new markets where SISLtech can offer its services and sell its products; identifying potential partners in foreign regions that can provide the company with support in commercial tasks; and superving the international activities of SISLtech.

Career path

I graduated in agronomy (the science and technology of using plants) in 2001. I was named best student at the University of Lleida, Catalonia, Spain, and received a PhD in environmental sciences from the University of Girona at the Laboratory of Chemical and Environmental Engineering (LEQUIA; www.lequia.udg.cat). After that I did postdoctoral work at the Consorci per a la Defensa de la Conca del Riu Besòs (www.besos.cat).

During my research career I have received three grants from the Catalan Government: the first one in 2002, and for a period of four years, to do a PhD in the LEQUIA research group (Reference: 2003FI 00921); the second one in 2005 to do a four-month predoctoral stage in the Technical University of Munich, Germany, to complement my PhD (Reference: DOGC 4313 01/02/2005); and the third one in 2007 for a period of two years to do the postdoctoral stage in the Consorci per a la Defensa de la Conca del Riu Besòs (Reference: 006 BP-B2 00).

From 2004 to 2009 I held the position of assistant professor at the University of Girona, Catalonia, Spain, teaching in the degrees of chemistry and environmental sciences, as well as in the Masters of environmental sciences and water science and technology. In 2009 I received the accreditation as a tenure-track lecturer and collaborating lecturer from the Quality Assurance Agency (AQU; www.aqu.cat). From 2009 I have been teaching the Master of environmental sciences.

I have been a member of IWA since 2004, and have participated in ten IWA conferences, with contributions published in international journals or as book chapters. I have also participated in another 19 contributions to national and international conferences, nine publications in international journals, and three in national journals, and I am a co-author of two books.

PROFILE

Adrian Alcayde
Department Manager, Research and Development, Manila Water Company Inc., Philippines

Position
I am Department Manager at Manila Water Company Inc. or MWCI, a privately-owned water company in the Philippines that provides water supply, wastewater and other environmental services to the East Zone concession area of Metro Manila, with a total population of approximately 5.5 million.

Key roles and responsibilities
The Research and Development (R&D) Department of Manila Water is responsible for all the scientific and exploratory works in the company, related to all environmental concerns and potential new services. As the Head of R&D, I am responsible for providing direction to the research agenda of the whole business. I am in charge of facilitating research projects to leverage on various technologies to create practical solutions and innovations. I am also in charge of promoting collaborative research between MWCI, the government, academics and other sectors related to water and wastewater operations.

Currently, the team is very lean in number, however it has the support of more than 1500 strong members of MWCI. With this, the R&D team acts as programme manager as well as project implementer. As programme manager, we are responsible for meeting the goals of each research project, using best practices in implementing the research. Part of our research portfolio includes sludge and biosolids management, wastewater process optimization, desalination and power savings projects. The R&D team is also heavily involved in all technical evaluation of feasibility studies and bidding documents for new facilities.

Background
I started with a BSc chemical engineering degree from the University of the Philippines (UP) and then started to work as an instructor in UP. A couple of years were spent in handling courses on transport phenomena, equipment design and studying chemical engineering thermodynamics in the laboratory. I also explored other opportunities in consulting by working with some senior colleagues who are involved in consultancy projects.

I was then given the opportunity to pursue post-graduate studies in 2006. I graduated in 2007 with a Master of engineering science at the University of New South Wales (UNSW) in Sydney, Australia, under the auspices of AusAID, the Australia Government's overseas aid programme. During my studies, I became involved with research on membrane bioreactors under the guidance of Professor Richard Stuetz (Faculty of Civil and Environmental Engineering) and Dr Pierre Le-Clech (UNESCO Centre for Membrane Science).

Upon going back to UP I was then promoted to Assistant Professor and given an administration role. With my experience and knowledge from Australia, I became part of a consultancy team with projects under Chevron Philippines. After almost seven years at UP I was persuaded to join Manila Water as the Head of the R&D Department.

Career path
I have been with Manila Water for almost a year and I enjoy working in this very challenging yet fulfilling environment. This is now the start of a very exciting period of my career as I have enough freedom to develop and implement projects. Moreover, it also brings out the finance-related mindset in me, which helps me in making business decisions. I am thrilled at the prospect of further increasing my capacity to lead projects, as well as contribute towards the development of each individual in my team and sharing the knowledge and experience with our colleagues, and hopefully the community. Moreover, I am looking forward to tackling more complex issues in water and wastewater, both technical and social in nature.

The communications challenge of involving customers

The scarcity of water is driving change in the provision of water supplies. **Tim Waldron**, CEO of Wide Bay Water Corporation, explains the challenges of altering supply practices and how involving the customer allows for a smoother transition.

Several years ago I was having a conversation with a gentleman who impressed me. He was a heart surgeon; an intellectual and an excellent well-read communicator. I was somewhat in awe of the wonderful work such highly talented and skilled people perform and I felt somewhat inconsequential in comparison when valuing my career skills to the life saving talents of this wonderful individual. However the surgeon used just as skilful a scalpel attack on my point of view when I declared this comparison, as he would have done in his daily operating theatre challenge. He pointed out that his ability perhaps at best allowed him to save one or two lives a week, and then commented on the fact that 20,000 children die everyday from either poor quality or insufficient water. He laid down the gauntlet for all water industry workers to take up the challenge and to realise the major role that they play in society. His parting comment was that a water engineer, scientist or manager can save far more lives than he can and better contribute successfully to a healthy life than doctors can ever do.

Providing a service

The modern day water utility has many roles to play in society. Essentially, a service supply of wholesome water quality plays a major role in ensuring the physical and mental health of the citizens. In developing countries, this work impacts even further on issues of life expectancy. In the modern urbanized society the engineer and scientist have different challenges, but usually to mass populations where water related health issues could impact several to large numbers of people.

All people working in the water industry throughout the world play a far more important role than perhaps they realise. Modern day management striving to achieve key performance indicator standards, efficient low cost production and delivery outcomes, is a thin veneer of all activities that relate to true customer service needs to society.

Our industry employs many technical, administrative and professional people who work both with the chemistry, hydraulics and management of delivering what customers need. Expectations are high. Everyone expects water to come out of the tap whenever it is turned on. The quality of water is expected to be aesthetically nice as well be healthy and enjoyable to drink. Additionally, every time people flush a toilet they expect all the waste to vanish without leaving odours and health problems. All that sounds relatively simple but many people around the world can only dream of such a service. Anyone who wishes to take up a career in the water industry will be helping society in one of its greatest challenges. You will not be shocked when I tell you that the water industry is very conservative in its ways. Engineering principles to resolve water hydraulic delivery problems 2000 years ago are still being used today. Underground pipework systems have changed little in the last few centuries.

Change within the water industry

At present, one of the wonderful things about working in the water industry is that all conventions to standard principles and norms are being challenged.

There is an eagerness being demonstrated throughout the water industry to take up the challenge of water scarcity and environmental impacts. Populations have embraced these issues and have declared a strong wish to ensure the impacts of essential needs have minimal environmental impact. No longer is it acceptable for rivers, streams and seas to be polluted from either industry or wastewater treatment plants. No longer is it acceptable for underground water pipe systems to loose a third of the water that travels through them from leaking joints and broken pipes. Society is embracing the protection of the environment and the better control of water resources. Heroes are appearing who are helping to make changes and prevent environmental damage.

However, along with this comes a major communication need from the industry to its customers who will want to know more and more information about the service they receive. Awareness is also needed about the cost of that service so that customers themselves can have wiser use of water, and also know how well the water utility is doing in providing these services in an environmentally friendly manner.

So let us look at what is changing in the water industry and some of the challenges.

Data collection

In a city called Hervey Bay in Australia, every customer now receives water through a water meter that gives far more information than the simple volume metric recording that has historically been used for charging purposes. Every customer now can be told not only how much water they have used in the last month, but also how much they used each day and each hour, whether they have a leak on their plumbing, what time of day they use the most water, how much they use for their garden or topping up a swimming pool as against how much they use in the house. They can even find out how much water their teenager used in that 45-minute shower they have just had!!!

A device that can be fitted inside the house can relay information from the water meter telling the customer how much water has been used for whatever period they want to know about. They can also find out how much their water bill is expected to be and how much it has cost each day. The water utility known as Wide Bay Water Corporation can let everyone know if they have a leak on their plumbing, and from the research they have done, can tell the customer what sort of leak they have, i.e. an underground pipe leak, a toilet valve leaking or even dripping taps. They can

Remote reading of meters. Credit: Wide Bay Water Corporation.

even advise customers if they have left taps running.

Charging for demand

All this sounds like wonderful customer service and has taken us into a different era, but perhaps the greatest benefit is still to be tested. This water corporation knows exactly how much water is being used and when it is being used every hour of the day. The potential therefore for time of day charging has arrived. One of the largest capital costs to a water utility is to have to construct larger trunk mains in order to meet a growing demand for water delivery at the peak demand time of day, usually between 6 - 8am in the morning.

If usage patterns for water can be changed then it is possible to defer the need for large trunk main upgrades and save millions, if not billions, of dollars across the world in developed urban areas.

Other utilities such as electricity and gas have already implemented such schemes and now the water industry will have this opportunity to further reduce its costs. I ask you to consider this question: how much extra would you have to pay for water between 6 - 8am in the morning that would motivate you to alter your water using habits during that period?

Of course the answer to this question will vary according to wealth of individuals. Many people say water is so cheap that you would have to put the cost up 100 times before they would alter either their usage or pay for plumbing alterations that would provide storage, which could be filled at low demand periods.

One thing is certain, good communication and dialogue with customers will be essential if we are to provide the customer needs in a more cost efficient way that embraces such radical changes.

Impact of drought

Scarcity of water focuses our engineers and scientists on new ways of controlling hydraulics. Most gravity control systems provide the minimum amount of water pressure at the time when customers actually require the most. Worst than this is the fact that these systems provide the maximum pressure in the middle of the night when we are all asleep and do not need that pressure. This has been the standard way of providing water through pipe systems for hundreds of years, i.e. give people what they want when they do not want it. So what is changing?

Droughts have focused engineers and scientists on reducing water losses from underground leaks. Detecting and repairing these leaks are demonstrating that pressure control is perhaps the most important beneficial application that can be applied to both reduce losses and unneeded demand. Although water pressure is essential for fire fighting purposes, too much of it results in a high frequency of bursts in pipes and also a higher flow rate through existing leaks. So controlling pressure has proved to both stop leaks occurring and reduce existing leakage enormously. Most of these applications have construction costs that can be paid for simply from savings made from reduced operational costs, less pumping, less water to treat with chemicals and usually pay for themselves within a period of three months to one year. Better still, these same systems can provide water pressure to customers at the time of day they need it and reduce it down to minimum levels in the middle of the night.

The introduction of district meters that measure water flows to every group of approximately 2000 properties combined with pressure controls is making a paradigm shift in customer service within the water distribution side of the industry. As water becomes more precious, more and more attention is being given to gaining knowledge of how much water goes where, and controlling its hydraulics to provide timely customer needs.

The introduction of flow modulated pressure control valves and variable

speed pumps has provided alternative methods to meeting the changing customer and environmental changes in our industry.

A glance at the skilled people in the present day high quality water utility demonstrates that they employ a long list of professional people, including civil engineers, mechanical engineers, electrical engineers, process engineers, network analysis engineers, water chemists, laboratory technicians, technical officers dedicated to leakage control, water metering, trade waste, sewer and water main pipework maintenance, fitters, mechanics and process operators that maintain pump stations and treatment plants, accountants and administration staff to keep the business economic, IT technicians and graphical information specialists as well as health and safety and risk management experts, who all contribute to such an essential service industry.

The challenge open to everyone who is in the industry or thinking of joining, is to come and demonstrate your brilliance in helping society meet one of its greatest challenges in managing water for the future. This means you! ■

PROFILE

Carol Howe
Project Manager, SWITCH

Position
I am just finishing up project managing a large European Union project called SWITCH (Sustainable Water Management Improves Tomorrow's Cities Health) for UNESCO-IHE in The Netherlands. SWITCH was a global action-research programme made up of a consortium of 33 global partners in 17 countries focused on developing the idea of the 'City of the Future', to include more sustainable urban water management through a combination of research, demonstrations, training and knowledge exchange. I recently relocated to the USA where I have started a consulting firm called FourEva Solutions while finishing my PhD and creating an eco-friendly homestead.

Key roles and responsibilities
For the last five years at UNESCO-IHE I was responsible for strategic planning and integration of the SWITCH Consortium activities. This included ensuring that partners worked together with local 'learning alliances' in the 12 SWITCH cities (Accra, Alexandria, Beijing, Birmingham, Belo Horizonte, Chongqing, Cali, Hamburg, Lima, Lodz, Tel Aviv, and Zaragoza), that the 15 or so demonstrations in SWITCH were progressing as planned, and that the training programme and dissemination materials were coordinated and strategically targeted at user groups and policy makers. On an operational scale I was responsible for the day to day finances and reporting for SWITCH, annual reporting and planning, and organising meetings of the management team and General Assembly. On the fun side I got to be involved in making film documentaries, writing plays, organising conferences and workshops, and representing SWITCH at global events.

I continue to be actively involved in the IWA Management Committees for the Cities of the Future programme, where Rebecca Brown from Monash University and I co-chair the Transitioning Group. I have worked on climate adaptation activities for quite a few years and continue on as an editor for the IWAP's Journal of Water and Climate Change, as well as just finishing an Urban Water Climate Adaptation Manual with ICLEI (an international association of local governments), UNESCO-IHE and IWA.

Background
My background was originally in wastewater and biosolids but over the years I have gained experience across the urban water cycle, including demand management, environmental flows, climate change adaptation, sustainability assessment and strategic planning. Before joining SWITCH I was Director of CSIRO's (Australia's National Research Organisation) Future Cities Program, a Board Member of the Cooperative Research Centre for Water Quality and Treatment, Manager of Strategic Planning for Sydney Water, a Principal Planner with MWH Consulting on the CALFED Bay-Delta Programme in California, US, and Residuals Manager at the Allegheny County Sanitary Authority in Pittsburgh, US. I got my BS from Penn State University in environmental resource management and started out as a wastewater treatment plant operator, but since then have been a construction manager, engineer, planner, consultant, director and any number of other titles.

Career path
In spite of being a planner I have never had a defined career path beyond trying to organise my family life and finances so that I could take advantage of opportunities when they came up. I have always done what interested me and that I am passionate about and things have happened naturally from there. I feel very lucky that my career choices have allowed me to travel extensively, meet people from many cultures and walks of life and always have new challenges to tackle.

PROFILE

Glen Trickle
Vice President and Director of Engineering and Technology, ITT Water & Wastewater

Position
As Vice President and Director of Engineering and Technology for ITT's Water & Wastewater business, I focus on the research and development of new and future treatment products and processes. Working as a global team, our engineers and scientists develop next-generation products that utilize disinfection, oxidation, filtration, and separation technologies to improve water and wastewater.

Key roles and responsibilities
My responsibilities focus on developing and implementing strategies that allow us to anticipate the future needs of our customers and then create and develop the products and processes that will meet these needs. Much of my time is spent investigating new water and wastewater technologies, often working with partners in academia to identify exciting new opportunities, talking to customers about unmet needs or meeting with regulators for insights into emerging issues. Once an opportunity is identified, I help determine whether these technologies will be developed internally or with external partners. As new products and processes are developed, I work with scientists and mechanical, electrical and electronic engineers to create the product offering. Our teams also serve as a technical resource for other areas in the company, often working directly with sales and application engineering.

Background
While studying engineering at Purdue University, USA, I had the opportunity to participate in a co-op study programme with industry. This experience helped me to appreciate the creative process associated with new product development and research and focused my future career aspirations. After graduating from the university, I obtained my professional engineering license as well as a certification in fluid power engineering. After working a few years in industry, I also obtained a Masters in business administration from the University of Wisconsin. I enjoyed the strategic and global perspective these studies provided and looked for career opportunities that integrated

engineering and business disciplines.

Career path
Throughout my career I have worked for global companies with worldwide operations, allowing me to travel extensively. Because of these experiences, I appreciate the complexities and benefits of working and living in different cultures. The global engineering and technology positions I have held allowed me to develop the skills required to lead cross-cultural teams, while gaining the experience in residential, commercial, industrial and municipal water and wastewater treatment to lead cross-functional teams.

I entered the water sector designing ultrapure water equipment and systems for applications in pharmaceuticals / biotechnology and academia. Later I became involved with the water treatment industry, where I expanded my scope to include residential, commercial, and industrial point-of-use and point-of-entry components, products and processes. I have directed worldwide centres of excellence for global new product development, a technology innovation centre and an India centre for design and research. Currently I am accountable for global teams that are creating the next generation of water and wastewater products. I am active in a number of industry associations and am the past chairman of the WQA (Water Quality Association) Water Sciences Committee. This involvement provides an opportunity to share information and to gain addition insights into the emerging needs of the water sector.

Driving policy with science – the case of drinking water disinfection by-products

For many years there has been a growing interest in the possible adverse affects of disinfection by-products and other trace contaminants in drinking water, with research results affecting health policy. However, a balance needs to be maintained between making sure the public is not exposed to harmful levels of chemicals that have a known adverse affect, and making sure disinfection of drinking water is thorough. Here, **Steve Hrudey**, Professor Emeritus, Analytical and Environmental Toxicology, University of Alberta, Canada, and **Jeffrey Charrois**, Director at the Curtin Water Quality Research Centre, Curtin University, Australia, discuss the responsibilities young water professionals have in developing the future of scientific research and public health policy.

Drinking water disinfection is absolutely essential. However, for over 35 years we have continued to ask – What are the health risks of disinfection? Prior to 1974 and the landmark publication of Johannes Rook,[1] followed closely but independently by Bellar et al.,[2] we were unaware that drinking water treatment processes actually created trace contaminants in drinking water. At that time we knew only about a relatively short list of contaminants in drinking water, primarily because of limitations in the available analytical methods. Until these publications, standard analytical techniques for identifying trace organics in water typically involved either: adsorption of analytes onto granular activated carbon to pre-concentrate contaminants, followed by desorption with chloroform and solvent evaporation to concentrate; or liquid-liquid extraction using chloroform.[3] Whichever method was used, both were understandably blind to chloroform.

Because of the remarkable scientific efforts of pioneers John Snow[4] and William Budd, we had known for more than a century that water was a primary route of transmission for the devastating diseases cholera and typhoid respectively. We continue to have overwhelming evidence that waterborne pathogens pose a major risk to human health worldwide.[5] The source of infectious agents, human faecal wastes, as well as animals (pets, livestock and wildlife), makes microbial pathogens a pervasive risk that will occur anywhere humans reside. This ongoing evidence means we have no uncertainty about the ability of microbial pathogens to cause human disease via drinking water ingestion. Consequently, we know that a failure to maintain effective disinfection of drinking water will inevitably allow disease transmission when contamination circumstances align.[6]

For comparison, disinfection by-products (DBPs) in drinking water are also a pervasive human exposure because of the consistent need to maintain disinfection, but our scientific certainty and confidence that these exposures via drinking water will cause human disease is inevitably substantially lower. Despite more than 35 years of research, the evidence for adverse human health effects from drinking water exposure to DBPs remains very uncertain and the need for controls on DBPs in drinking water is best justified on precautionary grounds because the human exposure to DBPs is inevitably pervasive.[7]

This situation provides an important lesson in policy and evidence for young water professionals because it is a major case of balancing competing risks and making policy decisions in the face of uncertainty in the scientific evidence. If we are to honour our commitment to science, we must accept the possibility that there may be no adverse human health effects from DBPs in drinking water until we have more compelling evidence than we have been able to obtain to date. To presume that there must be adverse human health effects strictly because we can document that humans are exposed to a large number of individual DBPs, most of which may demonstrate adverse effects at very high exposures in experimental animals, may be popular, but such presumptions are not good scientific practice. Precaution, on the other hand, as a policy presumption, is a reasonable exercise of public policy. Young water professionals need to be able to distinguish the difference between certain scientific evidence and sensible public policy.

Two relevant quotes from one of society's best communicators of science, Carl Sagan, are appropriate:[8]

'Of course we must be willing to change our minds when warranted by new evidence. But evidence must be strong. Not all claims to knowledge have equal merit.

'…at the heart of science is an essential balance between two seemingly contradictory attitudes: an openness to new ideas, no matter how bizarre or counterintuitive; and the most ruthlessly skeptical scrutiny of all ideas, old and new. This is how deep truths are winnowed from deep nonsense.'

The case of chloroform

The regulatory history of chloroform provides an excellent illustration of the interplay between scientific evidence and public policy. Soon after the revelations of Rook, in 1976 the US National Cancer Institute published the findings of a rodent cancer bioassay on chloroform which revealed a remarkably

high rate of tumors,[9] which quickly led the US Food and Drug Administration to ban the use of chloroform in a large array of consumer products, including mouthwash and toothpaste. The bioassay used chloroform dissolved in corn oil to deliver a massive daily bolus dose into the rodents' gut by gavage (feeding via syringe insertion), delivering doses that were 27 to 115% of a published median lethal dose for chloroform in mice.

It was almost ten years later that rodent bioassays repeated with chloroform dosing done via drinking water ingestion found that no excess tumors were produced in mice at chloroform concentrations of 1,800,000µg/l and for rats at 900,000µg/l.[10] These results clearly demonstrated that the tumour response for drinking water exposure had a threshold, which called into question the policy decision of treating chloroform as a no-threshold carcinogen. Combined with other evidence that showed no genotoxicity (DNA reactivity) for chloroform, the US Environmental Protection Agency (EPA) was convinced to propose in 1998 that chloroform was a carcinogen that exhibited a threshold. The proposal was met with such controversy that the US EPA withdrew it, but the chlorine industry challenged that decision in court and in March 2000, the US Federal Court ruled that the US EPA had failed to follow the requirements of the Safe Drinking Water Act to base regulatory decisions on the best available science.[11] The proposal to maintain a no threshold risk assessment for chloroform was withdrawn in May 2000, but a new threshold level of 70µg/l for chloroform was not adopted until January 2006. Even today, many water quality practitioners mistakenly believe that chloroform at drinking water exposure levels poses a cancer risk to consumers.[12]

Where does this situation leave the water industry with respect to DBPs? Most jurisdictions maintain criteria limits on individual or total THMs (trihalomethanes). Even though the best available science clearly shows that chloroform, the dominant THM, is not a cancer risk and the evidence for brominated THMs posing a cancer risk at the typically lower levels they are found in drinking water is not compelling, there has been and continues to be merit in limiting THMs in drinking water.

Trace chemicals and risk

The decades of research on formation and control of THMs has provided the water industry with a much better understanding of drinking water chemistry and more generally the behaviour of trace organic substances during water treatment processes. However, it is vitally important that water professionals do not misinterpret the limited health risks posed by THMs,[13] including very limited evidence of adverse reproductive outcomes, to compromise disinfection efficiency in search of lower THMs. Young water professionals need to recognize that the THM limits are set to provide sensible precaution for avoiding health impacts arising from the pervasive exposure to DBPs, but there is no basis to expect any reduction in adverse health outcomes if THM limits are lowered. Likewise, an occasional small exceedance of THM standards would not be expected to cause adverse health effects. There is a difference between sensible precaution and unwarranted precaution.[14]

Why then is there so much DBP research ongoing? Decades of epidemiologic research looking for evidence of human cancer being associated with exposure to chlorinated drinking water has found inconsistent and unconvincing evidence for all cancer sites evaluated except for bladder cancer. In that case, there is some consistency among a few studies suggesting that long-term exposure (more than 30 years) to chlorinated drinking water may be associated with an excess of bladder cancer, particularly in males. This remains a viable hypothesis, which continues to be the subject of

Research being undertaken at the University of Alberta to identify and characterize disinfection by-products in drinking water. Credit: Xingfang Li.

research evaluation. However, estimates of what proportion of human bladder cancers could possibly be attributed to chlorination DBPs have ranged from 2 to 17%,[15] which for the US would correspond to from 1200 to over 10,000 cases of bladder cancer per year,[16] while the maximum predicted number of cancer cases using cancer risk assessment estimates for regulated DBPs was only 92 cases per year for an exposed population of 263,000,000.[17]

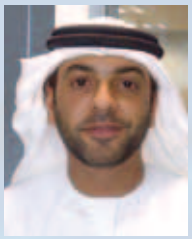
This means that currently regulated DBPs cannot possibly explain cancer predictions derived from epidemiology studies. Thus, either there are other, as yet unidentified carcinogenic DBPs which need to be found, or the epidemiological estimates may be an artifact of bias and / or confounding. Both possibilities are viable and continuing research is needed to clarify which will ultimately be proven correct. Viable lines of inquiry have included exploring the cancer risks posed by nitrosamines and MX (mutagen X) and related compounds. These are well established chemical classes of animal carcinogens, which are formed as drinking water DBPs and they exhibit much higher (100 to nearly 20,000 fold) carcinogenic potency than any of the regulated DBPs.

However, the levels of their occurrence in drinking water are correspondingly lower, meaning that these DBPs do not explain the cancer discrepancy. Another class of compounds, the halobenzoquinones, has recently been reported[18] and these are also likely to be animal carcinogens, but their importance has yet to be established. There is considerable scope for research into what DBPs can be formed[19] and what human health effects may be associated with them.

Young water professionals should remain true to the scientific method, which requires that we accept the possibility that there is no effect until we have gathered a sufficiently large body of evidence to reject the no-effect hypothesis with confidence. This evidence needs to provide sufficient detail and specificity that we can be confident about what measures are best to avoid the hypothesized effect. In the meantime, sensible precaution remains the best basis for public policy.

Young water professionals hoping to develop or implement public policy related to human health need to acquire enough understanding of toxicology and

PROFILE



Mohamed Yousef Almadfaei
Deputy Manager, Environmental Strategy and Policy Coordination, Environment Agency Abu Dhabi

Position

I work as the Deputy Manager of the Environmental Strategy and Policy Coordination Sector in the Environment Agency Abu Dhabi (EAD). EAD is the environmental regulator for the Emirate of Abu Dhabi.

Key roles and responsibilities

As I am working in the environmental strategy and policy coordination sector we are mainly involved in environmental policies and regulations. We finalized the development of the Environmental Vision 2030 for the Emirate of Abu Dhabi, which outlines the issues and challenges with regards to the environment and how do we like to see our environment in 2030. The five priority areas that are included are: climate change; air; water; biodiversity; and waste. Furthermore, I am working on managing a portfolio of position papers for EAD. These position papers include the issues and challenges with regards to some key environmental topics, such as groundwater and fisheries and how we as an agency see the solutions to tackling these issues. Moreover, I just finalized the Plastic Bag Policy along with my colleagues, which bans the use of non biodegradable plastic bags in the Emirate of Abu Dhabi.

Background

I am from the United Arab Emirates and I completed my BSc in environmental science from the University of St. Thomas in Minnesota, USA, in 2001. In 2009 I completed my PhD at the University of Reading in the UK in environmental management. The title of my thesis was: 'The impact of privatisation on the sustainability of water in the United Arab Emirates'.

Career path

I joined EAD in 2002 as the Secretary General Office Officer, where I actively participated in the development and preparation of the Abu Dhabi Global Environmental Data Initiative, which was launched at the World Summit for Sustainable Development in Johannesburg, South Africa, in 2002. I analyzed strategic meetings between EAD and various international and local organizations, and was actively involved in international stakeholder engagements and conferences. I then became a Lead Environmental Inspector within EAD, where I co-developed and implemented the Emirate's environmental inspection system, the chemical and hazardous materials monitoring system, and the code of practice for the Emirate of Abu Dhabi. I was also involved in field work that included inspections related to chemical and hazardous materials as well as inspections of industrial facilities.

In 2004 I was appointed Secretary General Office Chief Coordinator, where I coordinated the role for Secretary General Functions and was granted study leave to pursue my PhD degree in the United Kingdom. When I came back in 2009 I was a Senior Consultant within the Policy and Strategy Sector and I actively participated in the development of the Abu Dhabi Environment 2030 Framework. I was a member of the editorial board and the evaluation committee for all tenders related to 'Environment 2030'. I was managing projects related to the environment, and developed sections of the EAD's 2010-2014 strategy and strategic plan, leading the Energy Efficiency Policy and Water Resources Policy.

Since January 2011 I have been Deputy Manager of the Environmental Strategy and Policy Coordination Sector, and I am developing a comprehensive portfolio of position papers for EAD on all major environmental issues. I am leading the Abu Dhabi Water Collaboration Initiative and working in coordinating initiatives with the Water Resource Management Department. I am developing key sections of the Abu Dhabi Environment 2030 Vision, as well as fulfilling commitments as part of the Secretary General's Action Team. My ambitions are limitless and I am always looking forward to tackling new challenges in my work.

epidemiology to be able to understand the evidentiary basis for setting drinking water criteria. The case of DBPs and public health provide a good illustration of this need. ■

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PROFILE

Raman Kant
Director of NEER Foundation

Key roles and responsibilities

Keeping in view the urgency of enlightening the community and making efforts at the grassroot level in order to meet the growing need of water demand, I began my work in water conservation in 2004. I founded the NEER Foundation with the objective of creating awareness on various issues related to water, involving the community in finding various solutions for sustainable future. With a contribution of about 95 articles published in the Hindi national dailies, magazines etc., I have a wide range of experience and a deep understanding of various issues concerning water across India.

As the Director of NEER Foundation, it is my belief that environmental problems can only be addressed adequately if local people are involved in decision making at all levels and have control over resources. Led by him, NEER Foundation acts as an independent, not-for-profit voluntary organisation working towards environmental protection and management by means of water conservation and organic farming. NEER Foundation is involved in research, campaigns, grassroot level practical work and advocacy on issues related to environment and human rights. As a public interest organisation, NEER Foundation has focused on strengthening of the community through its active participation to achieve sustainable development.

Background

I graduated with a Bachelor of Arts (B.A.) from Chaudhary Charan Singh University in Meerut, India and trained in rainwater harvesting and aquifer recharge at India's Central Ground Water Board (CGWB).

Career path

As young, eager mind, whilst in my teens I formed a group of young dynamic leaders to make a difference to this world. I am a very restless and dissatisfied visionary, which makes me different from other people. The seed that was planted during my early days sprouted in 2004 in the form of NEER Foundation. With a mission and no funds I set out in the most difficult area of Western Uttar Pradesh to bring about a change, creating awareness on various issues related to water and sustainable agriculture.

While working on issues of water conservation, provision of safe drinking water, water quality and water resource conservation, it was realized that the problem stemmed from chemical-based farming methods being adopted by the farming community of Western Uttar Pradesh. Excessive use of pesticides and chemical fertilizers led to soil degradation, groundwater contamination and depletion, which was affecting the health of the population. Hence, the organization stepped in to promote biodiversity and organic farming. Since then the organisation has motivated more than 400 farmers to move from chemical-based farming to organic farming and biodiversity, replacing the monoculture of sugarcane and wheat with the cultivation of medicinal and aromatic plants, pulses, fruits, flowers, cereals etc.

Apart from working on environmental issues, it also works towards the betterment of marginalized communities by ensuring that they have basic health, education and civil rights. At this point, we vow to take our endeavour further and not to let down the expectations that our various well-wishers and supporters have vested in us. With each new year we aspire to touch more and more lives and leave the planet in a better shape than we inherited it in. Realizing that natural resources are limited and we are its caretakers we need to use it judiciously and conserve as much as we can for the future generations to come.

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PROFILE

Neakoh Mengyi
Partner, World Water Monitoring Day, Cameroon

Profile

My work involves rolling out World Water Monitoring Day (WWMD), an international education and outreach programme that builds public awareness and involvement in protecting water resources around the world by engaging citizens to conduct basic monitoring of their local water bodies. The Water Environment Federation (WEF) and the International Water Association (IWA) coordinate WWMD and officially observe it on September 18.

Key roles and responsibilities

I create awareness about WWMD and water quality issues through the procurement and distribution of testing kits, year-in-review reports, t-shirts, drawing bags and other promotional materials to schools and farmer organisations. I also plan and stage monitoring events with interested groups. Usually at the end of each session we do an assessment in a participatory approach, compile pictures and feedback, and then draft reports that are forwarded to the Global Programme Coordinator. I then get the data entered into the programme's database. I have recently been training teachers on monitoring techniques and generally on environmental education during seminars, as well as making inspirational keynote speeches.

Background

When I was growing up as a kid in my native village I knew water was free, always available and clean. This positive image completely changed when I was living in the city as an undergraduate student where the resource had a price, was sporadic and extremely turbid. I also discovered that I was a polluter like everyone else. The need to get the required tools and know-how to become an environmental steward pushed me to complete the following courses centred on the water environment: ecological sanitation; sanitation-related urban groundwater pollution; flood modelling for management from the UNESCO-IHE Institute for Water Education, Delft, the Netherlands; and international environmental law from the United Nations Institute for Training and Research (UNITAR). Prior to these post graduate short courses I obtained a BSc Hons in botany, and an Ingénieur Agronome certificate in crop sciences from the Universities of Buea and Dschang respectively in Cameroon.

Career path

Shortly after completing an internship on wastewater treatment at the Yaounde Gyneco-Obstetric and Pediatric Hospital, and assessing the risks of groundwater sources to pollution in slums of Yaounde, the capital of Cameroon, I obtained membership with renowned organisations working in the water sector, such as the Water Supply and Sanitation Consultative Council (WSSCC), the Gender Water Alliance (GWA), the EcoSanRes discussion forum of the Stockholm Environment Institute, the Sustainable Sanitation Alliance (SuSanA) and the prestigious WWMD programme. My active work and passion permitted me to make invaluable contributions on the international scene, such as during the 9th Meeting of SuSanA in Addis Ababa, Ethiopia, and the World Water Day 2010 at the United Nations office in Nairobi, Kenya. In 2010 my work in this programme positioned Cameroon in fifth position worldwide in terms of number of participants. I have also received the Water Champion Award Africa for two consecutive years for exceptional and devoted service for water quality education in Africa. With my award materials such as t-shirts, testing kits and drawing bags I have made generous donations to schools in Cameroon . These materials also helped to boost awareness as students have marched during the Cameroon National Day with placards, WWMD t-shirts, and testing kits.

Writing fundable proposals – the view from the other side of the fence

Before undertaking research, a research proposal is needed in order to gain funding for the work. **Jo Burgess**, writing as a reviewer, gives some tips on how to improve your research proposals.

Securing research funding is not easy, we all accept that. Your Masters and PhD probably did not include training for such a task, even though it is a cornerstone of your academic career. Much like when you are launched into your teaching load as a newly qualified lecturer, it is sink or swim time, so here are some water wings for those who have to raise funds to sustain their research groups and themselves.

First of all, start with the right attitude in your own mind. Shake off any potential chip that would like to reside on your shoulder: it is entirely fair that you have to raise your own funding. This is the way that the world of research works, and it ensures that only those with genuine passion for their subject are able to sustain it. There is only a finite amount of funding available, and if a person cannot work up the enthusiasm to even write a presentable proposal, what kind of self-motivated researcher will they make? Research is a marathon, not a sprint: the reality is that most research does not work (sorry). You will have hundreds of 'what was I thinking?' days for each 'Eureka!' day, but if those Eureka! days make the others worthwhile, then you are in the right place. So, accept that proposal writing is just and justified, and move on from there.

Secondly, understand the importance of the task and give it due effort. It is worth putting your all into your proposal, because it is the first impression you will make on the review panel that judges it, and the reviewers will assume that it is an indication of how you operate in the laboratory, in the classroom and in life. If your proposal is badly planned and hastily executed, it will give the impression that the other areas in your life are the same.

Thirdly, give the reviewers what they want. I cannot overemphasise the importance of this. I do not mean change your topic to chase the fashionable money, I mean give the reviewers a thoughtful, well-structured proposal that explains what you want to do and why, then how you plan to do it. Most if not all reviewers of proposals undertake their reviews in their own time, on a pro bono basis. They all want to enjoy reading the proposals, not spend their evenings and weekends ploughing through impenetrable documents, which leave them puzzled and weary. Try to empathize with your reviewers, after all, they have all been selected to review because they are successful researchers in related fields to yours. Put yourself in their shoes for a moment, they have already run this gauntlet many times over and they understand the difficulties you face. They must have a sense of collegiality or at least duty to the scientific community, or they would not be doing this voluntary work in the first place, so they will already be empathizing with you. Reviewers are not out to get you (or anyone else) and since they are not paid to read your proposals, they are not doing it for the money or for their own amusement either.

So, back in the shoes of the proposer, how do we achieve the perfect proposal?

A successful proposer understands and meets the aims of the proposal. Contrary to your own personal perspective (which is to get money to keep your lab running), the overarching aim of the work you are proposing to undertake is to improve the understanding of a particular subject in such as way as to benefit humankind, through improving the natural environment, medical technology, the way society functions, etc. You are trying to make the world a better place. In order to convey this aim, your proposal must be a story with a beginning, a middle and an end. Think of your proposal as a TRADER statement – Title, Rationale, Aim broken down into objectives, what you will Deliver, the Experimental procedure you propose to follow and the Resources you will require (staff, students, facilities and cold hard cash). Remember a trader is exactly what you are – you are selling the promise of new knowledge to the funding organisation and you have to ensure they view it as good value for money in order to secure your funding.

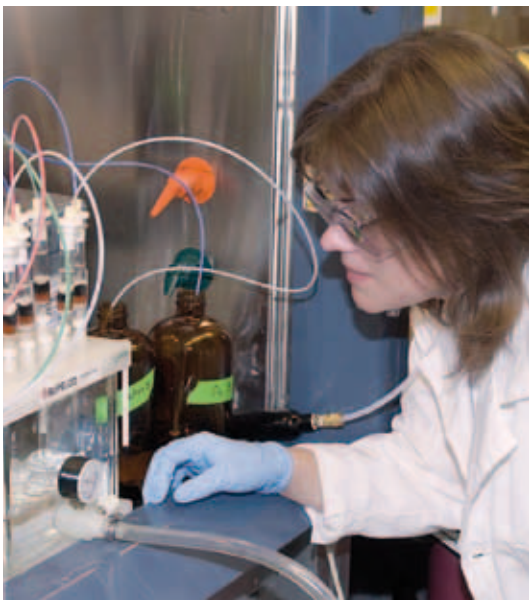
The purpose of proposals

The proposal is your shop window. It is the clothes you wear and the expression on your face when you shake the funders' hands. Get it right, and you are in for a long and productive relationship.

Enable the reader to understand the nature and purpose of the investigation. Give enough background for the reviewers to grasp the current state of knowledge in the field, define the knowledge gap that you wish to fill in, and clarify why they should care about it. This is the overall aim of your project.

Become conversant with the literature in your area and demonstrate this in the literature review and the methodology. Make sure the position of your study in the wider context of the field is clear. Break the aim into bite-sized objectives, each of which will address a research question.

Explain the methods you intend to use to provide data that will fill in the knowledge gap that you defined previously. Also ▶



Lab work at the University of Alberta.
Credit: Dr Xingfang Li.

explain very clearly how each subsection of the methods section will answer the research questions set out in your objectives.

Demonstrate scientific method (literature – hypothesis (aim and objectives) – rigorous test – conclusion – new hypothesis – design new test).

Understand the potential implications of your results. What will answering the research questions tell us? What will we gain from the new knowledge?

Demonstrate acceptable literary style throughout. You could have the answer to the meaning of life, the universe and everything but if you cannot communicate your answer in an understandable way, it will make no difference to anyone or anything.

Hints and tips for successful proposals

Good reviewers are hard to come by, and since most research or science councils routinely send each proposal to five or more reviewers, there is only a small chance that all of the reviewers' areas of expertise will be a 100% match for your proposal's topic. Explain all your abbreviations and do not rely on jargon, but give the review panel enough respect that you are not explaining that water is made up of hydrogen and oxygen. The key is to make the document accessible, both in content and presentation. Write for a technical but broad audience – scientists but not specialists.

General writing

If you use numbered headings do not use more than four number levels, i.e. no more than 1.1.2.2. Make sure you read the work through to make certain you have not dropped more than one heading level at a time. There is no need for '2.1 Introduction' – what else are you going to begin with? For example, it is better to have:

2. Materials and methods
The way in which x, y and z will be performed is given in the following sections.

2.1 Measurement of x
Use of words like 'optimum' and 'best' has to be in context. For example, phrases such as 'least cost' and 'most energy efficient' are more useful. Remember that 'optimum' is not always the same as 'maximum' and should not be used as a synonym. Also take care using words like 'fastest' and 'slowest' – these things imply finity.

Literature and sources of information: do not take the literature at face value! Look also at the context of the measurements reported, be especially wary of 'best', 'worst', and 'good'. Look for quantitative data and consider the aims of the researchers when they were drawing their conclusions. Is the reference applicable?

Make the proposal aesthetically readable as well as accessible in content. Use a locked space (also called unbroken space) in between items which must stay on the same line, such as units after numbers. To do this in MS Word, hold Ctrl and Shift when you press the space bar.

Use original, peer-reviewed references as much as you possibly can – journals instead of books, reports or conference proceedings. Never, ever, use internet references. Unless you have an in press journal article with a DOI, all internet sources are unmoderated and unreliable.

Nomenclature lists do not need to include standard abbreviations or formulae such as Cu, mg. Only list items specific to the proposal.

Reporting preliminary or literature results

In some proposals you will be building on your own previous work. In this case, make sure your team's or your contribution to the field is clear, but do not brag or fail to cite any references other than your own work. In other proposals you will be addressing gaps in the current state of knowledge. In both cases – you may need to report prior learning to justify the objectives and / or methods you are proposing.

Write in third person, passive past tense. 'An experiment was performed in which…'

Always use SI units and check the case (upper or lower) of the symbol.

Make sure that graphs of data which are to be compared to each other have the same scales on the axes and use the same legend for the same data series. Use logical legends – e.g. the controls are all ❍❑ and the tests could be ● ■. If the graph is quite busy then put annotations on the plot area to make things easier to understand without referring to a long legend.

Graphs should be a size which would fit six or eight onto a page. If you cannot see the symbols clearly at that size then use larger point data points. Similarly, use a suitable font size.

Figure legends and table captions should enable the reader to understand the figure or table without reference to the main text. The legend 'Figure 2. A plot of pH vs. metal concentration in solution' is no help in understanding what the graph means. This legend simply repeats the information in the axes. For example, include the conditions under which the measurements shown on a graph were taken: 'Figure 2. The response of pH to metal concentration after 30 hours incubation at 37°C.'

Figure legends are positioned underneath the figure (never in the plot or chart area) and table captions above the table.

Position figures and tables as soon after the first reference to them in the main text as is convenient. Never include a figure or table without referring to it in the text.

Materials and methods

Again, the watchword is to make the document easy to understand, otherwise your reviewers will not be able to judge whether you have selected appropriate methods that will answer your research questions.

Illustrate the methods as a flow diagram if there are several steps.

Give information for procedures which are new or modified. Do not include standard protocols – just give references for these. Nobody needs to read pages of standard methods. If the reviewer is familiar with the protocol they will not need to read it at all, and if they are not then give enough information for them to find the detail of the method in public literature.

Explain what each method will tell you in relation to the objectives. You will be asking for budget to do this work later in the proposal, so ensure that the necessity for each step is clear.

Budgeting

Itemise the budget as far as you possibly can. Do not use catch-all entries like 'lab items' but instead be as specific as you can about what you envisage needing for equipment maintenance and repairs, routine consumables like gloves, cleaning materials, standard chemicals and differentiate once-off items like instrument calibration in an annual budget.

State what all the important items are to be used for: if you are asking for capital equipment for example, state which of the objectives it will enable you to achieve.

Bursaries: specify how many people you need to support and at what level. Also clarify their roles in the project. Do you need a research assistant or a technician? Will this person achieve a qualification through their role in your project? Is this top-up funding, or their sole income?

If the organisation allows it, include a line item for contingencies (up to 10% of the total budget is reasonable) and one for knowledge dissemination (for items like journal page charges and / or conference fees to enable you to publish your work – however check carefully for rules regarding travel funding).

Describe any other funds sought or secured. Only conspiracy theorists think that this will put the funding body off giving you a grant: in most cases any organisation that sees that you may have, or you have already secured 50% of your budget from another source will be pleased that your proposal has passed or will be scrutinised by another organisation's review process, and be delighted to potentially get your research report for half price.

You are not bidding for a project, nor are you trying to make your fortune. Pitch the budget at what it will realistically cost to do the work well. The funders are looking for good value, not for the cheapest price tag, and they do not want to receive a report at the end which omits some of the work because you ran out of budget. This is why it is important to include detail in your budget – the cost of research is high and provided you have justified each item, do not be tempted to artificially decrease the total budget once you have added it all up and had a fright. At the other end of the scale, nobody should be trying to buy their shiny new SUV using what is often taxpayers' money. If you are appointed to a salaried position, for example, you do not need to claim hundreds of billable hours from public funds. Reviewers see both extremes, and usually reject both as candidates to receive funds.

Finishing touches

The last section of your proposal will be the one which aims to clinch the deal. If the proposal ends in an 'any further information' or 'concluding remarks' type of section, use the opportunity to reiterate why the community needs the new knowledge you intend to create and how well the work plan you have just described will enable this.

Finally, draft your proposal in plenty of time, and use all the resources at your disposal. Study the guidelines for proposers. It is amazing how many proposals are submitted which are incomplete or wrongly formatted, or both. Since panels of reviewers are involved and the fund managers have to compare many opinions on different proposals, the proposals must be directly comparable. So stick to the guidelines. Lastly, send your draft review to a colleague or mentor whose judgement you trust to check it before you submit. What is self-evident and unambiguous to you may not be to someone less involved in the specific topic, so seek feedback before submission.

After the submission has been made, you will receive the decision from the funding body. You may receive full funding, partial funding or a rejection. In each case, write back thanking them for the correspondence and asking for feedback if it was not already included. This will tell you what was good and not so good about your proposal, what to repeat and what to avoid in future. If you received partial or no funding, be gracious about it and use the feedback constructively to improve the proposal next time.

Nobody ever has every proposal they write funded; do not take the rejection to heart too much but instead learn from it and grow. If you received full funding, it is useful to know how closely you escaped the other two potential decisions, and what made the difference for your proposal this time around. And now that you have the money, the next challenge is to make good on your promises! ■

Advice on mobility, internships and funding for Young Water Professionals

When planning the start of your career, it can be difficult to know where to look first. **Blanca Antizar-Ladislao**, **Caetano Dorea** and **Hector Valdes** provide some helpful tips on how to build your future as a Young Water Professional.

Using the principles of biology, chemistry, and engineering, Young Water Professionals (YWPs) develop solutions to water and environmental problems. They are involved mainly in water pollution control, treatment, reuse, sanitation, water supply and public health issues. YWPs design municipal water supply and industrial wastewater treatment systems. They conduct research on proposed projects, analyse scientific data, and perform quality control checks. YWPs are concerned with local and worldwide environmental and water issues. They study and attempt to minimize the effects of global warming, municipal and industrial emissions. They also are involved in the protection of wildlife. The kind of work that YWPs do is very diverse, for example, YWPs can be a researcher, designer, planner, professor, government regulatory agency official, a manager, or be involved in professional society work.

The employer of YWPs can be private consulting engineering companies, universities, private research companies, laboratories, government agencies, etc. The work of YWPs can take them around the world. Since most environmental and water problems are located where there are concentrations of people, the largest number of job opportunities coincide with where the greatest number of people live. But YWPs may be also required to work in remote areas.

The preparation of YWPs may take several stages, requiring normally a Bachelors degree in engineering, probably civil, environmental, chemical or mechanical. A Masters degree in a relevant subject may provide adequate expertise, which more and more employers are looking for. Although not necessarily required, a PhD and postdoctoral experience may provide additional advantages in the subsequent career. Since water issues are so entangled with people, it is necessary that YWPs understand how people and societies function.

The role that YWPs can play through international mobility is immense by transferring technology and knowledge while they move, understanding different social and cultural aspects, and providing solutions to specific environmental problems. Sometimes, mobility has been difficult mainly because there was scarce funding available, and ocassionally difficult to obtain. Fortunately, nowadays there are many opportunities, including internships, scholarships and fellowships, which encourage and support international mobility of YWPs at different career stages, although these may differ from country to country (Table 1). Programmes for funding in the water sector may differ from country to country, but in general there is a reasonable amount of funding bodies that YWPs may be able to apply to, either independently or with the support of a more senior colleague, individually or as part of a group (Table 2). In any case, YWPs should plan ahead, bearing in mind that any plan must be flexible. In fact, jobs change, interests change, new opportunities arise. A good approach is to ensure a good understanding of the implications of each choice made might be and to be open for potential unforeseeable changes.

Opportunities for students

At an early stage, many universities encourage undergraduate students to gain experience in industrial and academic institutions. For example, The International Association for the Exchange of Students for Technical Experience (www.iaeste.org) aims at providing students in higher education with technical experience relevant to their studies and offering employers well-qualified and motivated trainees, while facilitating a source of cultural enrichment for trainees and their host communities. There are other programmes, such as the European Union's Socrates-Erasmus (www.britishcouncil.org/erasmus-about-erasmus.htm) and the Lifelong Learning programme (http://eacea.ec.europa.eu/llp/about_llp/about_llp_en.php) that facilitate mobility for students. Getting involved with a charitable organisation may also facilitate international mobility at an early stage. In the UK there are many charitable organisations (www.britishcouncil.org/eumobility-funding-charitable-organisations.htm), which provide support for research, as well as in other countries around the world (Table 3).

YWPs may gain an edge over others, and thus the best chance of securing a job and gaining valuable work experience, by doing an internship. Most of the programmes will have some requirements, such as studying in a particular country and work permits, as well as having an outstanding academic record. An internship usually takes the form of a vacation placement, which usually is between four and ten weeks over the summer. Internships allow YWPs to gain an insight into how the company works and, provided that the YWP makes a good impression, there are great chances of being offered a graduate placement, which might later on lead to a permanent position. Universities, research centres and small companies are normally very receptive to hosting undergraduates during their internships. Thus, even if this is not formally advertised, YWPs at an undergraduate level should seek for opportunities and contact key scientist or researchers working in the water sector in order to secure internships.

Opportunities for entry level young water professionals

Entry level YWPs normally encounter a larger amount of international mobility opportunities. Within academia, YWPs are encouraged to conduct web-based searching and find out what different departments or research groups do (http://univ.cc/world.php). The YWP should contact those groups and find out what scholarships are available. International offices at universities are normally very helpful. There are several rankings of universities around the world, which may help to identify the most prestigious departments (www.webometrics.info; www.thegooduniversityguide.org.uk).

Another option is to apply for available scholarships, normally advertised on web pages (e.g.: www.jobs.ac.uk; www.findaphd.com). Within industry, YWPs should explore types of jobs and companies and seek for graduate programmes that many companies offer (www.prospects.ac.uk). Water companies are a main employer, but other employers include regulatory bodies (www.environment-agency.gov.uk, www.epa.gov) and environmental organisations. Networking begins to play a very important role, and thus YWPs at this level are encouraged to participate in conferences and workshops (www.iwahq.org).

Opportunities for late stage young water professionals

Late stage YWPs with an important amount of knowledge and expertise should seek for senior positions, where they can make an impact in the development of new technologies and advance of knowledge. Available postdoctoral fellowships are normally advertised on the web (e.g.: www.aeesp.org; http://cordis.europa.eu/mc-opportunities). Research councils also fund research through prestigious programmes which secure tenure positions (e.g.: www.rcuk.ac.uk/pages/home.aspx; www.micinn.es/portal/site/MICINN). As for the entry level, late stage YWPs should also explore types of jobs and companies and seek for vacancies that many companies offer. Looking for a job is normally a long process, which may be started by identifying job vacancies. Several companies advertise their job vacancies on their web pages, and thus one should first identify water companies specialised in a specific area. Many companies also tend to advertise job vacancies online on specific job sites, such as IWA Publishing's My Water Career (www.my-water-career.com), Environmental Expert (http://water.environmental-expert.com) and New Scientist (www.newscientistjobs.com/jobs).

Helpful tips for YWP mobility, internships and funding

Various helpful for YWPs include:

- Identify in your own country weak areas which need specialised water professionals.
- Analyse your own strengths and

weaknesses in the water industry.
- Pinpoint the niche in which your contribution will be useful.
- Search for internationally recognised university departments in your area of interest (fully revise university and professor academic records: How many publications do they have in the concerned area? Do they have current projects in your area of interest? Do they have fully equipped facilities?).
- Once you decide which university you are interested in, prepare and send an application letter to the selected advisor professor (together with your CV, detailing your degree and grades).
- After you get the acceptance letter you are in the condition to apply to a fellowship. There are many fellowships available every year from different countries. Normally, online information can be found in the consulate webpage of your country of interest. Be aware that the whole process takes at least one year before the studies begin.
- Scholarship applications require specific documentation. Nowadays, there are many scholarship applications that can be done online, but in the end you will be asked for legalised hard copies.
- Bear in mind that learning the language of the chosen country will definitely help you to integrate into the country's culture.

Tips for (post)graduate school applications:
- Apply well ahead of the intended course start date. Some funding bodies require you to do so a year in advance.
- Make sure you have all the relevant documentation.
- Follow application procedures and guidelines carefully.
- Ensure your transcripts, diplomas, certificates, etc. have been translated into the appropriate language.
- The significance of your grades / marks should also be explained. Remember that different institutions and educational systems have different ways of ranking students.
- Be sure to emphasise on your application any degree obtained with a 'distinction', 'merit' or any other descriptor that highlights your excellence.
- Your CV should not be too long nor too short. A guidance is a maximum of two pages for applicants with an undergraduate diploma and three pages for applicants with a master's degree or equivalent.
- Make sure you clearly state your qualifications and experience. Avoid using abbreviations and acronyms; a very prestigious institution's abbreviated name may have no significance to someone from another country reading your CV.
- Take the time to research where you want to study. In your covering letter try to convey the message that the particular institution / research centre you are interested in fulfils your needs. Also, especially for PhD applications, be sure to show how your skills can contribute to the overall activities of the research centre. In other words, clearly state what is special about you and what is attracting you to that particular place to study.
- Avoid sending 'blanket' applications intended for the maximum number of institutions possible (see previous tip). This sort of practice is not very effective and can be seen as 'junk mail' or spam. Such applications are usually the first to be eliminated from any selection process. ■

Table 1. Summary list of countries and institutions that provide scholarships worldwide

Country	Funding institution	Web link
Australia	Australian Academy of Science	www.science.org.au
	Australian Research Council	www.arc.gov.au
	Australian Scholarships	http://australia.gov.au/topics/education-and-training/scholarships
	Australian Water Association	www.awa.asn.au
	Department of Education, Science and Training	www.science.gov.au
	My Future (scholarship search engine)	www.myfuture.edu.au
	National Library of Australia	www.nla.gov.au/oz/sciencew.html
	Water Quality Research Australia	www.wqra.com.au
Austria	Austrian Federal Ministry of Science and Research	http://bmwf.gv.at/startseite/forschung
	Center for Innovation and Technology (Wiennovation & the Vienna Business Agency) ZIT	www.zit.co.at
	Fonds zur Förderung der wissenschaftlichen Forschung (FWF)	www.fwf.ac.at/en
	Federal Ministry for Transport, Innovation and Technology - Föderkompass	www.foerderkompass.at
	FEMtech - Women in research and technology	www.femtech.at/index.php?id=36&L=2
	Jubiläumsfond der Österreichischen Nationalbank	www.oenb.at/en/welcome_to_the_oenb.jsp
	Life Science Austria (LISA)	www.lisavr.at/siteLayout.php?language=english
	Österreichische Forschungsförderungsgesellschaft mbH (FFG)	www.ffg.at/content.php? version=2
	Researcher's mobility Portal Austria	www.researchinaustria.info

	Wiener Wissenschafts-, Forschungs- und Technologiefonds (Vienna Science and Technology Fund) WWTF	www.wwtf.at/index.php?lang=EN
Belgium	Fonds de la Recherche Scientifique (FNRS)	www1.frs-fnrs.be
Bolivia	Viceministerio de Ciencia y Tecnología. ministerio de planificación del desarrollo	www.planificacion.gob.bo
Brazil	CNPq – Conselho Nacional de Desenvolvimento Científico e Tecnológico	www.cnpq.br
	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior	www.capes.gov.br
	Fundação de Amparo à Pesquisa do Estado de São Paulo	www.fapesp.br
Canada	Alberta Ingenuity Fund	www.albertatechfutures.ca
	Atlantic Innovation Fund (AIF)	www.acoa-apeca.gc.ca
	Canada Foundation for Innovation (CFI)	www.innovation.ca
	Canadian Institutes of Health Research (CIHR)	www.cihr.ca/e/193.html
	Canadian Water Network (CWN)	www.cwn-rce.ca
	International Scholarships	www.scholarships.gc.ca
	National Sciences and Engineering Research Council	www.nserc-crsng.gc.ca
	Networks of Centres of Excellence (NCE)	www.nce.gc.ca
	Social Sciences and Humanities Research Council (SSHRC)	www.sshrc.ca
Chile	Comisión Nacional de Ciencia y Tecnología (CONICYT)	www.conicyt.cl/573/channel.html
	Agencia de Cooperación Internacional del Gobierno de Chile (AGCI)	www.agci.cl
Europe	European Commission	http://ec.europa.eu
	European Union Research Organisations Heads of Research Councils (EUROHORCs)	www.eurohorcs.org
	European Science Foundation (ESF)	www.esf.org
	Human Frontier Science Program (HFSP)	www.hfsp.org
	The European Research Council	http://erc.europa.eu
Finland	Academy of Finland	www.aka.fi/en-gb
France	Centre National de la Recherche Scientifique (CNRS)	www.cnrs.fr
	French Ministry of Research and New Technologies	www.recherche.gouv.fr
	Institut National de la Santé et de la Recherche Médicale (INSERM)	www.inserm.fr/en/home.html
	L'Institut de recherche pour le développement (IRD)	www.ird.fr
Greece	National Hellenic Research Foundation (NHRF)	www.eie.gr/index-en.html
Germany	Alexander von Humboldt Foundation	www.humboldt-foundation.de/web/1600.html
	Bundesverband Deutscher Stiftungen	www.stiftungen.org/index.php?strg=87_124&baseID=129&
	Deutsche Forschungsgemeinschaft (DFG)	www.dfg.de
	Deutscher Akademischer Austauschdienst (DAAD)	www.daad.de
	ELFI Servicestelle für ELektronische ForschungsförderInformationen	www.elfi.info
	Federal Ministry of Education and Research (BMBF)	www.bmbf.de
	Förderinfo der deutschen Bundesregierung	www.foerderinfo.bund.de
	Max Planck Society for the Advancement of the Sciences	www.mpg.de

	Robert Bosch Stiftung	www.bosch-stiftung.de
	Volkswagen Foundation	www.volkswagenstiftung.de
Guatemala	Consejo Nacional de Ciencia y Tecnología (CONCYT)	www.concyt.gob.gt
Hungary	Hungarian Scientific Research Fund (OTKA)	www.otka.hu
Ireland	NRSFB	www.enterprise-ireland.com
	Science Foundation Ireland	www.sfi.ie
Italy	National Research Council (CNR)	www.cnr.it/sitocnr
Japan	Japan International Cooperation Agency (JICA)	www.jica.go.jp/english
	The Matsumae International Foundation	www.matsumae-if.org
Mexico	Consejo Nacional de Ciencia y Tecnología (CONACYT)	www.conacyt.mx
Netherlands	Netherlands Organisation for Scientific Research (NOW)	www.nwo.nl
New Zealand	Education New Zealand	www.newzealandeducated.com/scholarships
Nicaragua	Consejo Nicaragüense de Ciencia y Tecnología (CONICYT)	www.conicyt.gob.ni
Norway	Research Council of Norway (RCN)	www.forskningsradet.no
Oman	Centre for Environmental Studies and Research (CESAR) at SQU	www.squ.edu.om/center-environment/tabid/9153/Default.aspx
	Sultan Qaboos University (SQU)	www.squ.edu.om
	The Middle East Desalination Research Center (MEDRC)	www.medrc.org
	The Research Council (TRC)	www.trc.gov.om
	Water Research Centre at SQU	www.squ.edu.om/Default.aspx?alias=www.squ.edu.om/wrc
Panama	Secretaría Nacional de Ciencia, Tecnología e Innovación (SENACYT)	www.senacyt.gob.pa
Paraguay	Instituto Nacional de Tecnología y Normalización (INTN)	www.intn.gov.py
Portugal	Fundação para a Ciência e a Tecnologia (FCT)	http://alfa.fct.mctes.pt
El Salvador	Consejo Nacional de Ciencia y Tecnologia (CONACYT)	www.conacyt.gob.sv
Serbia	Serbian Chambers of Engineers	www.ingkomora.org.rs
	Jaroslav Černi Institute for the Development of Water Resources	www.jcerni.org
Singapore	Agency for Science, Technology and Research (A*STAR) Scholarships	www.a-star.edu.sg/AwardsScholarships/Overview/tabid/170/Default.aspx
	Environmental and Water Technologies PhD Scholarships	http://ijc.brightsparks.com.sg/profile/ewi/index.php
	Environment Technology Research Programme	http://app2.nea.gov.sg/ETRP.aspx
	The ASEAN Graduate Scholarship at the Nanyang Technological University of Singapore	http://admissions.ntu.edu.sg/graduate/scholarships/Pages/ASEANScholarship.aspx
	The National University of Singapore	http://www.nus.edu.sg/oam/scholarships-financialaid/scholarships/scholarship-index.html
South Africa	National Research Foundation	www.nrf.ac.za
	Council for Scientific and Industrial Research (CSIR)	www.csir.co.za
	Department of Water Affairs	www.dwa.gov.za
	Department of Science and Technology	www.dst.gov.za
	International Foundation for Science	www.ifs.se
	Medical Research Council	www.mrc.ac.za
	Science in Africa	www.scienceinafrica.co.za

	Mintek	www.mintek.co.za
	Agricultural Research Council (ARC)	www.arc.agric.za
	Water Institute of Southern Africa	www.wisa.org.za
	Water Research Commission	www.wrc.org.za
Spain	Agencia Española de Cooperación Internacional (AECI) (Becas ICI, Becas Mutis)	http://internacional.universia.net/latinoamerica/programas/aeci/index.htm
	Consejo Superior de Investigaciones Científicas (CSIC)	www.csic.es
	Fundación Carolina	www.fundacioncarolina.es
	Ministerio de Educación y Ciencia (MEC)	www.micinn.es
Switzerland	Swiss National Science Foundation (SNF)	www.snf.ch/E/Pages/default.aspx
United Kingdom	Biotechnology and Biological Sciences Research Council (BBSRC)	www.bbsrc.ac.uk
	British Chevening scholarships	www.chevening.com
	Engineering and Physical Sciences Research Council (EPSRC)	www.epsrc.ac.uk
	Natural Environment Research Council	www.nerc.ac.uk
United States of America	Fulbright fellowship	http://us.fulbrightonline.org/about.html
	American Association for the Advancement of Science and Engineering Fellows Program	http://fellowships.aaas.org/index.shtml
	Department of Agriculture Cooperative State Research, Education, and Extension Service	www.csrees.usda.gov/fo/funding.cfm
	Department of Energy	www.er.doe.gov/grants
	Ford Foundation	www.fordfound.org
	National Institute of Environmental Health Sciences Career Development Awards	www.niehs.nih.gov/careers/research/trainingfrom/index.cfm
	National Institute of Health Pathways to Independence Program	http://grants.nih.gov/grants/new_investigators/index.htm
	National Science Foundation (NSF)	www.nsf.gov
	Water Reuse Foundation	www.watereuse.org/foundation
	United States Environmental Protection Agency	www.epa.gov/ncer/fellow
	Water Environment Research Foundation	www.werf.org/Content/NavigationMenu/Funding/OpenRFPs/default.htm
	Water Research Foundation	www.waterrf.org
Uruguay	Dirección de Innovación Ciencia y Tecnología para el Desarrollo (DICyT)	www.dicyt.gub.uy
Venezuela	Ministerio del Poder Popular para Ciencia y Tecnología (MppCT)	www.mct.gob.ve

Table 2. Funding bodies around the world

Country	Funding institution	Web link
Australia	Australian Research Council	www.arc.gov.au
Europe	Seventh Research Framework Programme	http://cordis.europa.eu/fp7/home_en.html
United Kingdom	Research Council	www.rcuk.ac.uk
United States	Environmental Protection Agency	www.epa.gov/ow/funding.html

Table 3. Links of charities organisations around the world

Country	Funding institution	Web link
Australia	Australian Government	www.gov.au
Canada	Canada Revenue Agency	www.cra-arc.gc.ca/chrts-gvng/lstngs/menu-eng.html
International	United Nations	www.un.org
	United Nations Development Programme	www.undp.org
	United Nations Educational, Scientific and Cultural Organization	www.unesco.org
	United Nations Volunteer Programme	www.unv.org
	Organización de Estados Americanos (OEA)	www.educoas.org
	Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo	www.cyted.org
United Kingdom	Charity Commission	www.charity-commission.gov.uk
United States	Internal Revenue Service	www.irs.gov/charities/index.html

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