

Urban Water Security Research Alliance

Leading water research and knowledge in South East Queensland

Newsletter Issue 2

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A message from the director



This month, UWSRA will be officially halfway through its five-year mandate. Since the Alliance was formed in 2007, the water situation for SEQ has changed dramatically.

Back then dam levels were down to 16 percent and emergency measures were being put into place with new infrastructure being built to secure future water supplies.

Today, dams are 97 percent full across the region, Traveston Crossing Dam will not be built, and the State Government has decided that purified recycled water (PRW) will only be used as an emergency response when dams reach 40 percent.

The context has changed significantly and the Alliance is responding accordingly with a realigned program.

A new set of research priorities is emerging. There's a greater focus on reducing water grid demand, ensuring the quality of our diverse water sources and planning for efficiency and sustainability.

We now have a portfolio of 16 projects where we've got a refocused effort to pick up this change in context.

Some projects are coming to a conclusion, including the NDMA Formation Potential project and Disinfection By-Products (DBP) Formation and Minimisation in Drinking Water project.

We've had some great science results from each of these projects, and the plan now is to get the final reports written before shifting focus to look at DBP formation in alternate source waters across the Water Grid.

The PRW project is being discontinued in its current format to focus on four key project areas: hospital wastewater; pathogens and trace contaminants in reservoirs; assessing health risks of rainwater tanks and stormwater; and enhancing work on bioassays and risk communication.

I'd like to acknowledge the research that has been done in each of these areas, where we've seen excellent reports and outcomes that are already making a difference to SEQ's water management.

We're now involved in detailed planning to enable each of the new projects to commence seamlessly in this new financial year. A full list of the realigned programs and projects is included in Board News.

Our continuing projects are all largely on track and there are also two smaller project areas that we're scoping out: human reliability factors in managing risks in water supply systems; and 'water smart cities', looking at water from a broader regional planning framework.

The Alliance is at an exciting and dynamic stage and I look forward to reporting on our outcomes in coming months.

— Donald Begbie



MEET THE RESEARCHER

Professor Huijun Zhao is a chemist with specialist expertise in nanomaterials photocatalysis, electrochemistry and analytical chemistry. His current research focuses on the development of field-based online water quality monitoring systems for wastewater source control and recycling water quality management, as well as functional nanomaterials for solar energy conversion and storage. *Full story page 5.*

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Board News

The second Board meeting for 2010 was held on 18 May and discussion centred on refocusing the research program in response to the significant change in the water situation in SEQ and the outcomes of the strategic planning workshop held in March.

At that workshop, key stakeholders and members of the Research Advisory Committee discussed how UWSRA should respond to the major shifts in SEQ's water situation and the revised SEQ Water Strategy.

The Board decided to refocus the program around three core program areas:

1. Reducing Water Grid Demand

With less focus on purified recycled water and new dams in SEQ's water strategy, greater emphasis has been given to stormwater harvesting and rainwater tanks, and how we can maintain the water-conserving behaviour that the SEQ community has been displaying. UWSRA will focus this research

program on projects in:

- Stormwater Harvesting and Reuse
- Decentralised Systems
- Demand Management and Communication Research
- Residential Water End Use Study.

2. Water Quality of Water Sources

Under the new Water Grid, water is being drawn from a range of sources: desalination plants, dams, water treatment plants using chloramination and others using chlorination. This program aims to enhance community confidence in the quality of our water supplies by investigating the potential health risks of combining water sources, and from contact with stormwater and rainwater. The new program will include projects in:

- Hospital Wastewater
- Pathogens and Trace Contaminants in Dams
- Bioassays and Risk Communication

- Health Risk Assessment of Local Source Waters
- Enhanced Treatment
- DBP Formation in Alternate Source Waters.

3. Total Water Cycle Planning and Management to Enhance Sustainability and Efficiencies

This program area takes a wider consideration of not just the amount of water we can provide but of the impacts of supplying and using that water. The following projects will investigate those impacts and apply research findings to real case studies in SEQ:

- Climate and Water
- PRW in the Lockyer
- Evaluation Methods for Evidence-Based Total Water Cycle Planning
- Water Quality Monitoring Technology and Information Collection System
- Evaporation Loss.

The next Board meeting will be held on 17 August 2010.

Life Cycle Analysis (LCA) – Project highlights possible impacts

Nitrous oxide and methane emissions from wastewater treatment; methane emissions from dams; the energy burden of household rainwater tanks; and the impacts of nutrient runoff including the use of biosolids on farms are all issues that need further consideration in SEQ water cycle planning.

This is a finding of UWSRA's Life Cycle Analysis (LCA) project team from CSIRO, UQ and Griffith University.

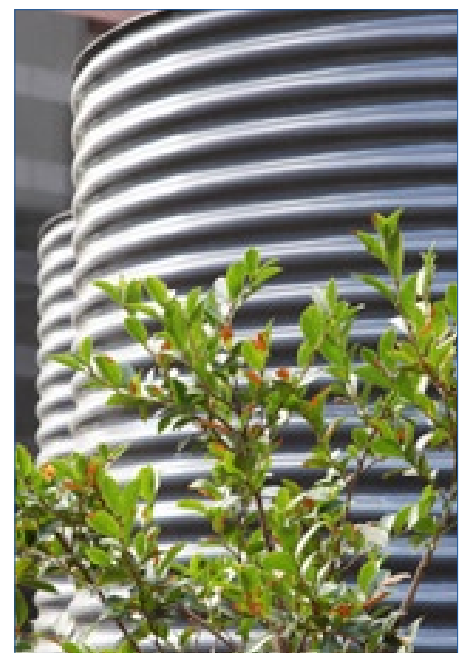
Joe Lane from the Advanced Water Management Centre at UQ said part of the project involved a detailed inventory of water infrastructure on the Gold Coast, to investigate the impacts for a typical SEQ urban

water system, and to consider the tradeoffs between different water supply approaches.

He said, to date, urban water cycle planning had focused on the issues of water use and nutrient discharges from wastewater treatment plants. However, other impacts such as global warming potential, resource depletion and chemical toxicity were emerging as important considerations.

"The LCA methodology is a sustainability tool that quantifies the potential for these impacts to occur," Mr Lane said.

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“Using the LCA approach, we’ve confirmed that if you want to reduce impact you should focus on improving the operation of the system. In most cases, the impacts associated with the manufacture of materials are less significant.

“We’ve also found that the wastewater sector makes the biggest contribution to most of the impacts associated with the urban water system, however the increased energy use of future water supply alternatives is also a concern.”

Mr Lane said rainwater tank technology could be improved after the Gold Coast study showed that tanks had a greater energy burden than traditional dam water supplies.

“This leads to an increase in GHG emissions and fossil fuel depletion, so there is real potential for their design to be improved,” he said.

He said the level of GHG emissions from dams was extremely uncertain, and further work was needed to confirm these impacts and find ways to mitigate them.

“Another area that hasn’t been considered much is the potential for

nutrients getting into waterways via the reuse of biosolids or wastewater,” he said.

“If you’re worried about minimising the impacts of nutrient discharges into water, you should not just consider the effluent pumped directly to the sea, but also look at how the application of biosolids on farms is managed.”

Mr Lane said now that the project team had identified potential issues, they would apply the LCA methodology to real cases in Queensland where new urban water systems were being planned.

Team tackles chemical risk

A study of two of SEQ’s major wastewater treatment plants (WWTP) has shown that they are consistently successful in removing most studied organic compounds by more than 90 percent.

A project team led by Dr Simon Toze (pictured right) from CSIRO investigated how effective the Luggage Point WWTP and Oxley Creek WWTP were in removing selected endocrine disrupting chemicals, as well as pharmaceuticals and personal care products.

Dr Toze said the WWTPs were performing well as a barrier in the recycled water train.

Comparisons were made on the basis of 11 different compounds including hormones, alkylphenols, pharmaceuticals and personal care products.

The results showed many compounds were very efficiently removed including caffeine (99.8 percent removal), estrogenic compounds (83.2–90.4 percent removal) and Ibuprofen (93.6–96.8 percent removal).

Dr Toze said, however, that in line with overseas studies it was found that the epilepsy drug carbamazepine was not removed through wastewater treatment processes.

“This is not a particular concern for the purified recycled water train, because the validation studies for the Western Corridor advanced water treatment plants demonstrated that carbamazepine is very efficiently removed through the advanced water treatment processes,” he said.

The team also took samples from different stages of treatment at Luggage Point and Oxley Creek WWTPs in order to better understand the removal of micropollutants during the treatment train.

They found anaerobic steps were less effective than aerobic steps (using oxygen) at removing the organic compounds studied.

Dr Toze said the study’s future directions would be on risk assessment and helping to answer the “what if” questions that the public asked about in relation to what is contained in treated water.

“The results obtained so far indicate that we know about most of the chemicals in wastewater and their removal through treatment,” he said.

“There are, however, a very small amount we don’t know about and these need investigating.

“For example, we need to be proactive in looking at newer chemicals such as perfluorinateds, the precursors to Teflon, and similar



chemicals which have only recently begun to be studied.”

Dr Toze said the research team would investigate what detection methods were necessary to study a range of compounds, such as benzalkonium chloride (widely used in hospitals and laundries), perfluorinateds, the fungicide propiconazole, the antidepressant venlafaxine, cytotoxic drugs, antivirals and selected antibiotics.

Rising temperature concerns

UWSRA researchers have found that while human-induced climate change may be decreasing the amount of water flowing into Queensland's dams, natural variability is the main cause of reduced rainfall in Queensland over the past ten years.

CSIRO scientist Dr Wenju Cai is leading UWSRA's Climate and Water Project, in conjunction with colleagues from the Queensland Department of Environment and Resource Management (DERM), and Griffith University.

The project team has run simulations using a downscaling climate model to transform outputs of a range of global climate models into catchment scale information with improved accuracy and geographic detail, to better inform SEQ's water strategy.

"We found that the rainfall reduction in SEQ seemed to be multi-decadal variability, or natural variation," Dr Cai said.

"While the rainfall reduction may not be due to climate change, we know that rising temperatures are due to climate change.

"When you have a very hot day or heatwaves water demand increases, so does evaporation, and energy consumption increases dramatically.

"One of the ways rising temperature could affect water supply is that the efficiency of converting rainfall into dam inflows will decrease."

Dr Cai said his team had so far conducted six, 140-year simulations for SEQ and these outputs were being used by DERM for their hydrological model to more accurately predict inflows to SEQ storages.

He said global climate models provided future climate information at a resolution of several hundred kilometres, which did not resolve SEQ catchment features.

"The downscaling model we used means that for the first time we have been able to provide DERM with climate information at a resolution of 15km across SEQ to run the



hydrological model," Dr Cai said.

To take into account uncertainty arising from differences between one model and another, one approach is to use as many models as possible that perform well over the Australian region to obtain a multi-model average.

"We've used five global climate models. This time next year we'll have eight models and this will help remove variability between the models and increase the accuracy of prediction. We are also going to evaluate whether an even higher resolution of 8km makes a difference to our prediction."

Dr Cai said one of the biggest challenges in climate modelling was accurately representing the centre of Pacific tropical convection. The location of the centre of Pacific tropical convection matters to SEQ rainfall simulation as tropical convection is a very important climate driver for the tropical east coast of Australia.

"On a global scale we know that tropical circulations are expected to weaken in a warming world and tropical convection is expected to decrease, thus affecting rainfall," he said.

"At the moment though, climate models are not converging on where the decrease will be, because the convection centre varies from one model to another and this causes differences in the prediction of impact for SEQ."

Publications

For a list of UWSRA publications including journal articles, reports, conference papers and annual reports, visit: <http://www.urbanwateralliance.org.au/publications>

Water facts

1. SEQ has nearly 80,000 rainwater tanks, a figure which is expected to grow to 600,000 by 2026.
2. Under the Queensland Development Code the targeted water savings per household per year for new detached houses is 70,000 litres, while for new townhouses and units it is 42,000 litres.
3. The chemical disinfection of drinking water with chlorine last century saw cholera rates drop by 90 percent in the US, along with an 80 percent decrease in typhoid and a 50 percent decrease in amoebic dysentery.¹
4. UWSRA research indicated trihalomethane (THM) formation potentials of SEQ's source waters were consistently below the Australian Drinking Water Guidelines of 250 mg/L.
5. Studies have shown that 90 percent of bacteria such as salmonella are removed in less than five days and completely removed in 15 days in SEQ dams.

¹ Richardson, S. D., et al. quoted in Knight, N., Shaw, G., Sadler R. and Wickramashinghe, W.

Meet the researcher

Huijun Zhao

**Professor and Director of the Centre for Clean Environment and Energy
Griffith School of Environment,
Griffith University**

Project Leader of the UWSRA Water Quality Monitoring Technology and Information Collection System project

Professor Huijun Zhao (pictured right) is a chemist with specialist expertise in nanomaterials photocatalysis, electrochemistry and analytical chemistry. His current research focuses on development of field-based online water quality monitoring systems for wastewater source control and recycling water quality management, as well as functional nanomaterials for solar energy conversion and storage. Professor Zhao has been the chief investigator on projects attracting grants of more than A\$8.5 million since 2002. He has published over 100 papers in refereed journals and registered over 50 patents. Professor Zhao came to Australia from China in 1988, initially working at the University of Wollongong then the University of Western Sydney before joining Griffith University in 1997.

Q. How did your career path bring you to Australia?

A. From 1982 to 1988, I was an associate lecturer then lecturer at North-eastern University in China. In 1988, I was selected by the Chinese government as a talented young academic to be sent overseas for further training. I was lucky enough to be selected to study in Australia as an exchange lecturer. I took a scholarship and did a PhD here, as China did not have PhD programs in Chemistry at the time.

Q. Your background is in analytical chemistry. How did you become involved in research into water quality information management?

A. Research funding and end-users' needs have been the main drivers for me to get into water research. Functional nanomaterials



became a hot topic of research in the late 1990s. In early 2000 when we were investigating the photoelectrocatalytic degradation properties of nanostructured titanium dioxide I quickly realised that such a principle could be further developed into a new chemical oxygen demand (COD) detection method for rapid determination of organic pollutants. Current standard COD methods take about two hours and use highly toxic, corrosive and expensive chemical reagents. We developed a nanotechnology-base method, PeCODTM, which requires no calibration or toxic reagent and is capable of determination within 30 seconds to five minutes.

Q. How is your research contributing to Australia's future water security?

A. Every day we use water and generate wastewater. If we can safely reutilise the wastewater we generate, then purified recycled water will become a reliable water source to dramatically improve the security of water supply. Our Water Quality Information Collection System project is developing a technological tool capable of providing an early warning for water grid managers to enable them to rapidly respond to an incident and better manage any risks.

NDMA unlikely concern for SEQ

The good news resulting from UWSRA research undertaken by Dr Nicole Knight (pictured right) in SEQ is that disinfection by-products (DBPs) such as nitrosodimethylamine (NDMA) and trihalomethanes (THMs) are unlikely to be a concern for SEQ's drinking water.

Dr Knight is a research fellow at Griffith University who has been working with Glen Shaw from Griffith and colleagues from The University of Queensland (UQ) on UWSRA's DBP Formation and Minimisation in Drinking Water project.

NDMA and THMs can be formed during the water treatment process as a by-product of disinfection by chloramine and chlorine. Their occurrence in drinking water is strictly controlled through the Australian Drinking Water Guidelines.

The team has been examining DBP formation potential in seven SEQ source waters to identify any current or emerging issues.

Dr Knight said one major finding was that SEQ should not have any problem complying with Draft Australian Drinking Water Guidelines introduced earlier this year, as no NDMA was found in any of the finished waters.

She said the absence of NDMA was partly due to the fact that SEQ source waters were not highly wastewater impacted but also because water treatment plants were using appropriate treatment methods.

"There's one plant in SEQ that uses polyDADMAC as a coagulant aid (to remove organic matter that could react with disinfectants to form by-products), which has NDMA precursors," Dr Knight said.

"However, we were able to confirm that that plant did not have any detectable NDMA (<5 ng/L) in their finished water and that's probably because they use chlorination.

"It's an important outcome for operators to know that if they are using polyDADMAC, they should be able to safely use chlorination, whereas using chloramination could see a large increase in NDMA formation potential."



Dr Knight said the research also indicated THM formation potentials of SEQ's source waters were consistently below the Australian Drinking Water Guidelines of 250 µg/L.

She said another important outcome of her study was that enhanced coagulation, commonly used in early stages of water treatment, had different outcomes for water containing high levels of bromide.

"Bromide is not removed in the enhanced coagulation process, which would normally lower formation of DBPs such as THMs, and can actually increase total THMs in high bromide source waters.

"While it's been previously observed that you can get an increase in brominated THMs after enhanced coagulation, to my knowledge this is the first time an overall increase in total THMs has been observed."

Dr Knight said one of the next priorities for the project team was looking at novel strategies for removing bromide.

She said she would also be working with UQ's Dr Maria José Farré Olalla on a project that will include developing analytical methods for emerging DBPs.

"Maria and I will work to find an appropriate surrogate or indicator for DBPs arising from chloramination and we're also going to be looking at if there are any particular risks for DBP formation arising from combining water from different sources in the distribution system," Dr Knight said.

Conference Alert

Below is a list of conferences happening around the world in coming months that may be of interest to people involved in water research or industry.

UWSRA is not necessarily affiliated with these conferences.

Australian Desalination Summit
15–16 July 2010, Melbourne.

Enviro 2010 – Solutions for a Sustainable Future
21–23 July 2010, Melbourne.

AWA Odours Specialty Conference
24–25 August 2010, Sydney.

World Water Week 2010
5–11 September 2010, Stockholm, Sweden.

Hydrology Conference 2010
11–13 October, San Diego, California, US.

13th International Riversymposium
11–14 October 2010, Perth.

Water Loss Asia 2010
13–15 October, Kuala Lumpur, Malaysia.

6th International Conference on Sewer Processes and Networks
7–10 November 2010, Gold Coast.

STORMWATER 2010 — Stormwater Industry Association National Conference
9–12 November 2010, Sydney.

Membranes and Desalination Specialty Conference IV
9–11 February 2011, Surfers Paradise.

Diary Dates for 2010

17 August and 23 November
Board meetings

28–29 September
UWSRA Annual Science Forum

16 November
Research Advisory Committee meeting