

Urban Water Security Research Alliance

Leading water research and knowledge in South East Queensland

Newsletter Issue 3

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A message from the director



This year has been pivotal for the Alliance, as we reached the halfway point of our five-year mandate.

In reflecting on the work that's been done to date, we've delivered some great science with several projects completed and four new projects up and running, in line with the changing landscape of water management in South East Queensland (SEQ).

In September, we saw the fruits of this labour on show at the Annual Science Forum, which drew 206 people over two days.

We had great feedback from stakeholders who heard about some of the research results from each of the Alliance projects. Keynote speakers contributed their own expertise.

Stuart White from the Institute of Sustainable Futures at UTS emphasised the critical role of water savings and supply issues, from simple strategies such as dual-flush toilets to the emergence of integrated water service providers.

He provided a salient reminder that water supply issues are very much tied up in energy, nutrient waste and other broader issues of sustainability that will impact the future of water security in Australia. His presentation really helped set the scene and established an important platform that the Alliance is already responding to.

The acting CEO of Yarra Valley Water, Pat McCafferty, also addressed the forum with his vision for moving to a secure water future, ensuring Yarra Valley's customers come with them in creating outcomes that are highly sustainable for the community. This was a good pointer for us in Queensland to see where we might be heading when our dams might be at emergency levels.

Visiting European scientist Dr Adriano Joss from Eawag, the Swiss Federal Institute of Aquatic Science and

Technology, provided us with a European perspective of water reuse.

With this of course come issues of micropollutants, not just from a health perspective but also from the perspective of community concern. In Europe the focus is very much on source control and advanced water treatment, which presents many opportunities for the Alliance in sharing knowledge across these fields as our efforts in this area are significant.

As part of that knowledge sharing, we are delighted to welcome a new project leader who also comes from Eawag, Professor Beate Escher, who is the focus of this newsletter's Meet the Researcher article.

Beate is leading the Bioassays and Risk Communication project. She and her team are working with Dr Fred Leusch from the Smart Water Research Centre at Griffith University on bioanalytical methods for monitoring water quality in SEQ.

The year has also seen us farewell our Hospital Wastewater project leader from The University of Queensland, Dr Christoph Ort, whose project will now be managed by Dr Kristell Le Corre. Christoph's leadership was instrumental to the key finding from the project, which was that for most of the investigated pharmaceuticals, hospitals contribute less than 10 percent of the total load of pharmaceutical residues in sewage.

The key aspect of the Alliance's research mandate over the past few years has been its ability to respond to a changing landscape in SEQ's water industry. While we have delivered significant outcomes to date, we look forward to contributing even more significant results in the coming two years, and hopefully beyond.

We wish all of our stakeholders and researchers a very happy festive season and look forward to reporting on more great achievements in 2011.

— Donald Begbie

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New tools are proving purity of water

UWSRA research using bioanalytical assays has established that the quality of purified recycled water (PRW) is at least as good as bottled water when it comes to organic micropollutants. The research has also proved that bioanalytical assays are a useful tool for assessing water quality in the production of SEQ's drinking water and recycled water.

Professor Beate Escher is leading the new Bioassays and Risk Communication project, and her team from the National Research Centre for Environmental Toxicology (Entox) at The University of Queensland (UQ) are building on work already undertaken in the PRW project by postdoctoral researcher Dr Miroslava Macova under the leadership of Dr Simon Toze, CSIRO.

The results of the study to date have shown bioanalytical tools are useful in helping to identify potential issues or risks of micropollutants to

humans or the environment.

Professor Escher said bioassays demonstrated how cells responded to various chemicals, and allowed researchers to produce a measure of the toxic effect of a mixture of chemicals, expressed as a "toxic equivalent concentration" (TEQ).

She said TEQ translated the effect of the mixtures of the many unknown and unidentified chemicals in a water sample to the effect a known reference compound would cause.

"What's really important is that by using these bioanalytical tools, you get a more comprehensive picture than if you were only doing chemical analysis, which is very costly and can be quite tedious," she said.

"Also, in analysis you only pick out certain chemicals among thousands and you also have to account for chemicals being transformed during water treatment.

"Even if the parent compound might have disappeared, the transformation product might still be toxic or in exceptional cases even be more toxic than the parent.

"The bioanalytical tools give us a measure of the possible mixture effects of all chemicals, including transformational products, and are a good adjunct to chemical analysis."

The project leader said this was the first time researchers had

monitored the effect of every step of the PRW treatment train on organic micropollutants.

The research team has found that toxicity of samples was reduced across the seven treatment barriers. Six bioassays were used and each bioassay showed a different picture for the varying chemicals and their mixture effect.

In all cases, the micropollutant burden was significantly decreased by wastewater treatment and the toxic effect was further reduced after reverse osmosis and advanced oxidation treatment to levels not significantly different from bottled water or to an undetectable or insignificant level.

Professor Escher said the team is now focused on identifying appropriate threshold levels to give scientific guidance for regulators to use in determining safe levels of micropollutants occurring in mixtures.

"For example, we can look at the TEQ of estradiol — a very potent human hormone — and we might say that if the water elicits the equivalent of a certain level of estradiol, that is safe, but that another level might impact fish health and any higher than that may cause issues for human health," she said.

"We plan to run mixtures and get a feeling for how these thresholds can be set by the regulators."



Board news

The fourth and final Board meeting for 2010 was held on 17 November. A key highlight for this year has been the realigned program, and the group spent much of this meeting consolidating the direction of the program and reviewing progress.

This year, the board welcomed Karen Waldman who is the new CEO of the Queensland Water Commission and farewellled former QWC Acting CEO Dan Spiller who

has moved on to a role with the SEQ Water Grid Manager. Dan made an enormous contribution to the Board and offered excellent advice on the policy issues in the water sector, as well as on the relevance of project work.

As a group, we are aware that while our focus is very much on providing deliverables by the end of this research program, we must also look to the future to see how the Alliance's work may continue beyond the life of the program.

New projects underway

The realignment of the Alliance program earlier this year means we have 17 projects under way, under three core research areas: Reducing Water Grid Demand; Water Source Quality; and Total Water Cycle Planning and Management to Enhance Sustainability and Efficiency.

Of these, there are seven new projects building on work that's been completed or in response to a change in strategic priorities due to the changing water situation in SEQ.

A brief summary of each of the new projects follows.

Four projects have grown from work previously completed under the Purified Recycled Water (PRW) project:

Hospital Wastewater

The project team is compiling and evaluating audit data from all public hospitals in Queensland. The team will then aim to confirm the audit data and previous results by conducting a second hospital wastewater sampling campaign. Additionally, the project team will investigate whether antibiotic-resistant bacteria are more abundant in hospital wastewater than domestic sewage.

Pathogens and Trace Contaminants in Dams

This research project seeks a better understanding of contaminants in dams and reservoirs, and to investigate what natural treatment processes might remove them.

Bioassays and Risk Communication

The results of the study to date have shown bioanalytical tools are a useful adjunct to chemical analysis in identifying potential issues or to predict potential risks of micropollutants to humans or the environment. See the Project in Focus article in this newsletter for more details.

Health Risk Assessment of Local Source Waters

This project will investigate the type and occurrence of pathogens in stormwater and roof-harvested rainwater to identify what microbial health risks might exist. The team is testing types and number of pathogens, as well as the impact of tank location and other potential sources of pathogens.

Other new projects include:

Assessment of Disinfection By-Products in SEQ Drinking Water

This project builds on completed work in the formation potential and minimisation of disinfection by-products (DBPs). In its current phase, the project is investigating the occurrence and fate of emerging and regulated DBPs in drinking water as well as ways to analyse, measure and assess them. The second phase will investigate DBP formation as a consequence of mixing different source waters, and explore strategies to reduce DBPs by improving halide and organics removal.

Water Smart Cities

The initial phase of this project aims to bring together current national and international knowledge on this topic to identify key principles which underlie sustainable urban water system design. Investigation and analysis of these principles will then be undertaken with the intent of identifying the potential for a generic analytical framework for monitoring the sustainability of alternative urban water systems.

Human Factors in Water System Safety

This is a small scoping project aiming to advance the knowledge of the role, importance and risk mitigation of human factors in urban water system safety. The outcome from this research would help create a safe and resilient water system where the human elements of judgement, decision-making, perception and management, are well integrated with the technical systems, risk-management systems and quality control mechanisms.

In addition to the new projects, there has been a significant change in direction for three of the continuing projects.

Demand Management and Communication Research

This project grew out of the findings of the Systematic Social Analysis project, which initially focused on



investigating people's attitudes, behaviours and acceptance of PRW. The research is now focused on three sub-projects:

- **Demand Management** — social research into water-use attitudes and behaviours, the data from which will be used to develop and test water conservation interventions;
- **Decentralised Systems** — a survey of more than 600 SEQ home owners will explore the social factors that determine acceptance and uptake of decentralised systems, such as rainwater tanks and greywater systems; and
- **Risk Communication** — field experiments to explore how best to communicate with SEQ residents to increase their knowledge and acceptance of alternative water supply systems.

Evaluation Methods for Evidence-Based Total Water Cycle Planning

This project builds on the research conducted by the Life Cycle Analysis and Integrated Modelling project, which provided valuable insights into the impacts and energy trade-offs of the various components of the total water cycle in SEQ. The project will now aim to apply and adapt these evaluation methods within the context of Total Water Cycle Management planning in two case study areas in SEQ. The team also aims to quantify the impact of rainwater tanks and other decentralised systems on both the supply/demand balance and water/constituent balance at the SEQ regional scale.

Evaporation Loss

The original Water Loss project examined loss through both system leaks and evaporation. It provided valuable research on a novel technique for leak detection and location, using a support vector machine to more accurately predict the location of leaks in the reticulated water supply system. This project will now focus exclusively on measuring and reducing evaporation from large water storages. See the article in this newsletter for more details.

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. A baseline survey taken during winter 2010 shows SEQ per capita average residential water consumption was approximately 145 L/person/day, or 370 L/household/day.
2. Baseline data from the Residential Water End Use Study shows the greatest contribution to water usage in SEQ is showering (29 percent), with clothes washing contributing 21 percent, general tap use 19 percent and toilet use 16 percent.
3. A study of communal rainwater systems on the Gold Coast showed total specific daily energy use for the communal rainwater system was 6.2 kWh/kL, with the potable pump contributing 3.9 kWh/kL.
4. A sensitivity study of the Lockyer Valley PRW scheme estimated salt travel times across a 20m unsaturated zone were modelled between seven years and 371 years. The time lag between irrigation pulses and groundwater recharge pulses varied between 150 days and 16 years.
5. Chemical films and monolayers placed over a dam system can either absorb or reflect UVB at the water surface by at least 25 percent, which may have a positive influence on aquatic ecosystems in preventing UV damage to organisms.

Meet the researcher

Beate Escher

Deputy Director

National Research Centre for Environmental Toxicology (Entox)

The University of Queensland

Professor Beate Escher is an environmental toxicologist originally from Germany.

She received her PhD in Environmental Chemistry from the Swiss Federal Institute of Technology in Zürich (ETHZ). Prior to joining Entox, she worked as a senior scientist at the Swiss Federal Institute of Aquatic Science (Eawag) in Dübendorf, Switzerland, and lectured at ETHZ. Beate is chief investigator on various projects on water quality assessment including UWSRA's Bioassays and Risk Communication project and two ARC projects: one on the fate of micropollutants in water recycling; the other on development of innovative dosing techniques for cell-based bioassays. Beate has authored 86 peer-reviewed publications and two book chapters.

Q. What sparked your interest in environmental toxicology?

A. I did my "junior year abroad" at Rutgers University in the US studying environmental sciences and had a summer job at their Blueberry and Cranberry Research Centre. I was fascinated by the people and the science they were doing there. At the time I was studying chemistry and although synthesising chemicals was very interesting and I loved it, I didn't see how I'd do that for the rest of my life. Environmental science connected my scientific interest with my interest for the environment and nature so I decided to do a PhD in it, which I did in Switzerland.

Q. What brought you to Australia?

A. I did a sabbatical with Entox for two months in 2005 and it was really fascinating as I worked for the first time with passive sampling in Jochen Mueller's team and this work brought me from the lab into the field (and



what a nice field site Queensland is). When the opportunity came up to return to Australia, I took it. I really enjoy collaborating with engineers and other people from the water industry, and in our team we have half the people working on fundamental science while the other half work on more applied projects around water recycling.

Q. When did you first start using bioanalytical tools?

A. I really started at the source of wastewater in the late 1990s — I was working on a large urine source separation project in Europe called Novaquatis. The project involved using no-mix toilets to recycle urine and make fertiliser. My role was to check there were no adverse impacts from chemicals in the fertiliser and that was when we first started using bioanalytical tools. The project is still running in several developing countries.

Q. How will your research into bioassays contribute to solving Australia's national water problems?

A. We are creating a nice complementary tool to chemical analysis that allows the water industry to be more certain and have more information about what chemicals are present in water and to what extent they might have an effect.

Science win may boost dam storages

A unique application of technology in the Alliance's original Water Loss project has brought us one step closer to accurately measuring and controlling evaporation over large water storages for the first time.

Now under the auspices of the Evaporation Loss project, researcher Dr David McJannet from CSIRO said the team was confident that it had good baseline measurements to enable them to start applying evaporation control methods — something which is yet to be achieved effectively for any large water storage in the world.

Dr McJannet said the project had used three independent evaporation estimates for dams in SEQ to come up with the baseline data.

"We've used eddy covariance (a flux measurement technique), a water balance technique and a new method known as scintillometry, which is where a laser beam is passed across the water surface and is perturbed by heat rising off the surface," he said.

"This is the first time the technique has been used over water.

"The use of scintillometry has been a big science win for us and we've got almost perfect agreement between the eddy covariance technique and the scintillometry."

Dr McJannet said the team would now work on applying a monolayer film, developed by CRC Polymers, and monitoring the performance of the product in reducing evaporation in a one-year trial.

He said colleagues at USQ were working on a distributed application system, which would dispense set dosages of the monolayer product at different times during the day in order to keep a continuous cover of the film over the water.

"The project will now focus on monitoring evaporation rates and water quality and ecosystem health before and after application of monolayers to the dam surface," Dr McJannet said.



"Another component of the project will look at the behaviour of these monolayer films under different wind and wave conditions in a controlled laboratory wave tank.

"Researchers at Griffith University are now applying the product and looking at how it performs under different wave and wind actions".

Dr McJannet said the enemy of the monolayer was the wind blowing it off the surface but the molecules of the new CRC Polymers product had been designed to grip onto the water surface.

"If the product is as successful as lab trials suggest we should be able to see quite clearly that it's making a difference to evaporation loss," he said.

"Also, one of the biggest hurdles to adoption of monolayers is potential impact on water quality.

"The UQ and CSIRO researchers will be monitoring the quality and chemistry of water before and after applying the film to see what impact the monolayers have."

Dr McJannet said if the monolayer product application was successful and the price competitive, it would provide "another alternative solution to preserving some of the water we collect in our dams".

"Some dams easily lose half of the water they collect from evaporation so if we can simply apply a product like this and keep evaporation losses down, we can increase water security for farmers and larger reservoirs, and get more productivity out of those systems because less water will be lost from the dam."

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.)

IWM 2011: International Conference on Integrated Water Management

2–5 February 2011, Perth

AWA Membranes and Desalination Specialty Conference IV

9–11 February 2011, Gold Coast

Ozwater 2011

9–11 May 2011, Adelaide

Water Resources Management 2011

23–25 May 2011, USA

Water Australia Summit 2011

29–21 July 2011, Sydney

International Desalination Association (IDA) World Congress 2011

4–9 September 2011, Perth

Water Reuse 2011: International Water Association

26–29 September 2011, Spain

2011 International Water Conference

13–16 November 2011, USA

First International Conference on Water and Society

5–7 December 2011, USA

Diary dates for 2011

15 Feb, 17 May, 23 Aug and 16 Nov

Board meetings

15 March

UWSRA Stakeholder Forum

6 April and 15 Nov

Research Advisory Committee meetings

7 April

Management Board Strategic Planning session

14–15 Sept

UWSRA Annual Science Forum