Urban Water Security Research Alliance

Fact Sheet November 2012

Rainwater tanks in SEQ

Over the coming years Australia's growing population and drying climate will significantly increase demands on our water supplies. Rainwater tanks provide a useful alternative source of water, reducing our reliance on mains water supplies. The Urban Water Security Research Alliance (the Alliance) has undertaken an integrated research program to inform strategies for the effective design and management of rainwater tank systems to sure their full benefits are realised. This research validated the important role tanks can play in reducing demand on South East Queensland's (SEQ) Water Grid.

Australia's vast rural communities have had a long association with the use of rainwater tanks due to the limited availability of water infrastructure in remote areas and the unreliable water supply from a variable climate.

Urban households have increasingly adopted rainwater tanks as a water source since the mid 1990s, in response to government policies to reduce demand on centralised water and the restrictions introduced by recent drought conditions and El Niño weather patterns. From 1994 to 2010, the number of capital city households that use rainwater tanks has more than doubled, increasing from 407,000 to 1,030,000. Urban rainwater tanks are mainly used for toilet flushing, clothes washing and garden watering, which are a large component of domestic water use.

Recently, a drop in popularity for the installation and ongoing use of rainwater tanks has been caused by the easing of drought conditions and increased density of urban housing seeking to maximise space usage whilst minimising cost. Concerns about health risks associated with mosquito breeding further impacted tank uptake. The increasing demand for water in our cities coupled with decreasing supplies due to predicted long-term changes in climate conditions presented a need to substantiate the potential performance of rainwater tanks. Alliance research investigated the effective design, use and management of tank systems to inform best practice for rainwater tank urban environments.

In SEQ rainwater tanks have become an important alternative for local water supply to reduce demand on the SEQ Water Grid and defer the need for additional bulk water supply infrastructure. In 2007, the Queensland Government introduced mandatory water savings targets for all new Class 1 (residential) buildings as part of the Queensland Development Code.

Rainwater tanks are a common sight in suburban areas across South East Queensland.

The most common method for achieving these targets has been to install rainwater tanks that are internally plumbed into the household's laundry cold water tap, toilet and outdoor taps. The number of rainwater tanks installed in SEQ is projected to grow from 300,000 in 2010 to 500,000 by 2026.

Research outcomes to date

The Alliance addressed many of the research needs associated with rainwater tanks. Our multi-disciplinary research has provided increased understanding for improved rainwater tank design and management, and has highlighted areas where further investigation has the potential to deliver the greatest benefits.

Queensland Government
National Research FLAGSHIPS Water for a Healthy Country CSIRO
Griffith UNIVERSITY
The University Of Queensland AUSTRALIA

Water savings

Prior to this program of research it was widely agreed that rainwater tanks have the potential to save considerable amounts of mains water. However, the exact water savings that can be expected for SEQ households were unclear. Alliance researchers used 2009 and 2010 water billing information to examine water savings in households with internally plumbed tanks.

The average mains water saving was found to be approximately 58 kilolitres per household per year or 50 litres per person per day (roughly one bath tub of water per household per day). This is equivalent to 34 percent of water used in residential households in those years and equates to a saving of around $150 per year for the average household.

A real-time monitoring study of 20 households conducted between 2011 and 2012 with smart water metres measured a mains water savings of approximately 41 kilolitres per household per year for the Brisbane region.

Internally plumbed rainwater tanks provide an average mains water saving of 40 to 58 kilolitres per household per year, which is 30 to 35 percent of average household water use.

Results from physically inspecting the set-up of tank systems in 200 homes in SEQ indicated that the roof area connected to the tank is often below the minimum requirement of 100m². Hence, further water savings could be achieved by increasing the connected roof area.

Overall, Alliance research results demonstrate that rainwater tanks are effective in achieving significant water savings, greater than the anticipated 24 percent savings that was used in Queensland's Development Code in 2007 during pre-drought conditions.

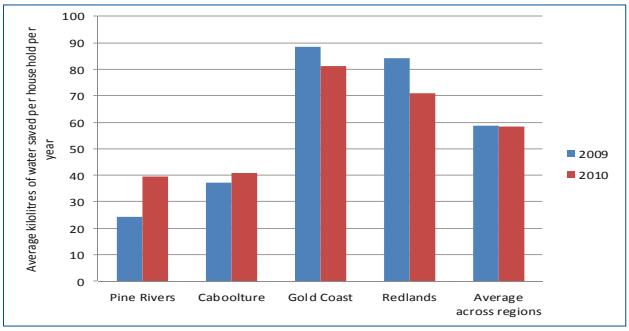
These findings will help inform future water portfolio planning by enabling more accurate forecasting of the water savings that rainwater tanks can provide.

Energy efficiency

Previous research suggested that rainwater tanks are considerably less energy efficient than traditional water supply. To understand factors that impact energy usage, Alliance researchers analysed water flow characteristics and the operation of rainwater tank pumps in a controlled model house setting.

They concluded that the most commonly used pumps are efficient for high-flow applications, such as watering the garden, but much less efficient for low-flow applications, such as toilet flushing and the washing machine. With pumps often operating in their low efficiency range, there is considerable potential to improve energy efficiency of pump systems.

Correct rainwater tank pump sizing and system configuration can achieve energy efficiency of less than 1.5 kilowatt hours per kilolitre of water.



The average household mains water savings for each of the analysed regions across South East Queensland.

The research indicated that correct pump sizing and informed selection of system components could significantly improve energy efficiency to less than 1.5 kilowatt hours per kilolitre of water. Furthermore, households with automatic switching devices use about 25 percent less energy than those with trickle top-up. The best results are achieved when the intended end use of the water is matched to the pump size and system configuration.

Ancillary devices, such as pressure vessels that are properly sized and used with the correct size pump can further reduce the energy footprint. This research has shown that the energy footprint of rainwater tanks is lower than other alternative water sources, such as desalination and recycled water.

Alliance research has shown that connected roof area, effective tank size and efficient pumps are all critical factors in optimising water yield and energy efficiency of urban rainwater tanks.

Ultimately, a highly effective tool to improve design and increase energy efficiency is to give householders greater access to information about the water requirements of various appliances in urban dwellings and how tank system components operate.

This research has demonstrated that energy efficient systems can be achieved. Attention should go towards improving tank system design and installation practices. The next step will be to incorporate this knowledge into the development of system configuration or installation guidelines for tank owners.

This model house allowed researchers to control system variables and investigate the energy efficiency of different tank pumps.

Tank maintenance

Water savings and energy efficiency are not only influenced by system design but also by system management, making this an important consideration for achieving maximum benefits from rainwater tanks over the long-term. Alliance researchers conducted a series of surveys to provide insights into the way people manage and maintain their tanks. The surveys showed a small but significant difference in the maintenance habits between owners of mandated tanks and owners who voluntarily retrofitted their tanks. Retrofitters were more self-motivated towards rainwater tank maintenance and were keen to learn more to ensure the longevity of their tank. Conversely, owners of mandated tanks felt that they did not know enough about maintenance and were less willing to find out more or undertake the required maintenance behaviours. These results are of concern as a lack of maintenance could lead to faster tank deterioration and diminished return on investment.

Owners of retrofitted tanks were more self-motivated towards tank maintenance than owners of mandated tanks.

Alliance research revealed self-management approaches as both easy to implement and an effective solution to tank maintenance. Central to these approaches were increasing community awareness; communicating the benefits and value of tank maintenance; and providing a web-based resource with various support services, including a maintenance schedule tailored to the individual tank owner.

The findings around tank maintenance suggest that greater information and guidance is needed following tank installation as well as promoting tank maintenance behaviours.

Tank owner and non-owner attitudes

Research into the attitudes of rainwater tank owners and non-owners found that participants were more likely to install a rainwater tank if a severe water shortage occurred, or if they believed they could be vulnerable to water shortages. Conversely, reasons for not having a tank included lack of space, cost, mistrust in authorities and those governing water, or a belief that water shortages were no longer a threat in SEQ. Encouragingly, most tank owners were happy with their system, however, this was strongly dependant on how well the system had been designed and installed and how competent owners felt in managing their tank.

Reasons for not installing a tank include a lack of space, cost, mistrust in authorities, or a belief that water shortages were no longer a threat.

By increasing hands-on tank knowledge and skills, information and education programs have the potential to improve maintenance behaviours and owner-satisfaction as a result of owners feeling more competent in the management of their tank.

An Alliance researcher samples rainwater tank water for testing.

Health risks

Alliance research also investigated the potential health risks associated with the use of water from rainwater tanks. Analysis of samples from 80 rainwater tanks from across SEQ showed that 71 percent of tanks did not meet Australian Drinking Water Guidelines due to the presence of *Eschischeria coli (E. coli)*. Some samples were also found to be positive for pathogens, including a small number with active potential to cause human infection. As *E.coli* is present in animal faecal matter, these results are not surprising considering the high incidence of possums and birds on urban roofs. Further research is needed to test for pathogens in the faeces of other animal species, such as flying foxes, rats and frogs.

Samples from 71 percent of tanks did not meet Australian Drinking Water Guidelines.

The project team also examined the inactivation of indicator microorganisms in animal faeces on the roof, in gutters and tanks due to the effects of sunlight and temperature.

The research showed that direct sunlight on a roof completely deactivated faecal indicator bacteria in a matter of hours and less than a day in clean gutters. However, under shaded conditions, the same level of pathogen die-off took up to four days.

These results strongly suggest that regular cleaning of roofs and gutters and pruning of overhanging tree branches to prevent shading on the roof might be an effective way to reduce animal faecal contamination in rainwater tanks.

The results reinforce government recommendations that, where mains water is available, water from rainwater tanks should only be used for non-drinking purposes unless adequately treated.

This research will help guide the development of transparent, accurate and valid policies and guidelines for the treatment and use of water from rainwater tanks.

Communal rainwater tank systems

Alliance research determined that communal rainwater systems, with some top-up supply source, can provide a reliable water source. Importantly, communal rainwater tank systems could be used to address owner maintenance issues and potential health risks. To better understand these systems, Alliance researchers investigated a communal rainwater system in SEQ that delivers 37 kilolitres of harvested rainwater per household per year based on local conditions. Researchers assessed the management model and community perceptions associated with this system. These findings will help determine how to maximise efficiency of communal tank systems as a useful option for rainwater harvesting.

Communal rainwater tank systems may be more appropriate in medium density developments where there is high building ratio limiting available space for individual rainwater tanks.

Birds and possums on roofs are the likely source of contaminants in rainwater tank water.

Future research opportunities

The significant body of integrated research undertaken by the Alliance provided answers to a wide range of questions around rainwater tanks in SEQ. However, this research has also highlighted opportunities where further investigation would provide valuable insights.

- Cost-effectiveness of rainwater tank systems – Further research should focus on the cost-effectiveness of both individual and communal rainwater tank systems, in comparison to other alternative water supply options.
- Maximising mains water savings – What changes would need to be made to the design and installation of individual and communal rainwater tank systems to reach their full water savings potential?
- Minimising energy use, maximising yield reliability – What are the optimal tank system designs for different housing configurations to maximise energy efficiency and yield reliability?
- Managing health risks – Further research is required to better understand how processes such as sunlight, natural biota and hot water systems can reduce the health risk of pathogens in rainwater tanks. This will help inform guidelines for appropriate treatment and the potential for wider use of rainwater, such as in showers.
- Optimising the longevity of tank infrastructure – Very little is known about the existing condition of tanks across SEQ, their likely lifespan and how this may be affected by tank maintenance. Research aimed at enhancing owner awareness and improved tank operation and maintenance programs, including the owners' willingness to pay for such a service, would help ensure the longer-term benefits from rainwater tank investment.
- Exploring options for roof water supply services – Many of the above issues may be better managed through alternative roof water supply service models. Research is needed to investigate and inform the design of effective service models that deliver social, environmental and economic benefits.

Following through on these research opportunities will not only help ensure that the SEQ community derives maximum water supply benefits and return on investment in rainwater tanks, but could also help position the region as a world leader in rainwater tank design, management and service provision.

Further information

More detail on the above research can be found on the Alliance web site at www.urbanwateralliance.org.au

Contact details

Dr Ashok Sharma

CSIRO Land and Water

Ph: +61 3 9252 6151

Fax: +61 3 9252 6288

Email: ashok.sharma@csiro.au