CRC for
Water Sensitive Cities

Program C: Future Technologies | Project C4.1 | Project duration: July 2012 - July 2017

Integrating multi-functional urban water systems

Overview

Stormwater biofilters (also known as rain gardens or bioretention systems) and constructed wetlands are currently regarded as two of the most promising water sensitive urban design (WSUD) technologies. For example, biofilters are highly efficient in reducing runoff volumes, and in removing solids, nutrients and metals from stormwater while having a relatively small footprint. Stormwater wetlands, that can be very effective flood control measures, are often regarded as the key amenity assets in our urban areas. These systems are multi-functional technologies that harvest water for people's use, protect waterways from polluted and elevated urban discharges, beautify urban landscapes, and improve microclimate by enhancing evapotranspiration.

This project will deliver multi-functional hybrid WSUD systems capable of treating multiple water sources (such as stormwater, greywater, partially treated wastewater and polluted groundwater) within urban landscapes. It will focus on water recycling of multiple water sources in urban areas, and further development and optimisation of stormwater biofiltration and wetland systems to better protect our waterways and cool our cities. It will also focus on estates of biofilters to incorporate ornamentals and climbing plants.

Key outcomes

The key outcomes of the project include the development of:

- constructed stormwater wetlands that can function well within groundwater dominated hydrology systems of the Coastal Plains around Perth
- green wall technologies that could treat greywater while providing thermal isolation to buildings and cooling to the surrounding areas
- hybrid biofilters for treatment of multiply water sources within urban landscapes, for example, harvest stormwater during wet periods and treat greywater during dry periods
- stormwater biofilters that are esthetically pleasing as well as effective in water treatment
- adoption guidelines for these new technologies including guidance on design, operation and maintenance.

These new WSUD technologies could be adopted by local and state planning authorities and water utilities. Water system technology manufacturers and service providers, urban land developers, building contractors, and engineering and design consultants will also benefit from these developments.

Multi-functional biofilter and wetland performance: Facts and insights

So far the work has been done only on monitoring stormwater wetlands located in Perth, Western Australia. The hypothesis is that stormwater wetlands that are under influence of natural groundwater systems will have different performance compared to stormwater constructed wetlands that are disconnected from the groundwater. The first preliminary results are still inconclusive.

The work on multi-functional and hybrid biofilters, including green walls and living walls for greywater and stromwater treatment, commenced in July 2014 and involves the selection of light weight media as well as ornamental and climbing plants that can support healthy green and living walls. It also includes a laboratory study on ecological carbon sources (low-cost waste products) that can enhance nutrient removal in the submerged zone of biofilters, which is of particular importance for treatment of wastewaters of high nitrogen strengths.

Current knowledge about green and living walls includes the following:

- Green and living walls can reduce summer temperatures on a street by 9oC, offering a direct advantage to business and commercial districts.
- They considerable reduce the need for cooling of the buildings on which they are installed, while also creating an aesthetically pleasing feature.
- A current disadvantage is their need for large amounts of water to function (approximately 1-5 litres per square metre each day), which is the main reason why they are not commonly used in Australian cities.

An Australian Government Initiative

CRC AUSTRALIA

Project design

The project will compare wetland systems from the Coastal Plains around Perth including a natural groundwater dominated system and a constructed system disconnected from the water table. This will result in the development of a wetland model able to simulate ecological and hydrolgoical responses to changes in water availability.

Laboratory studies (large-scale column tests) will help optimise stormwater biofilters capable of treating wastewater as well as polluted groundwater for a number of flow rates and wetting/drying regimes. This will lead to the development of hybrid biofilters that can treat polluted groundwater and wastewater during dry weather as well as capture and treat stormwater during wet weather. The project will particularly focus on the development of living walls and green walls for water recycling, thermal isolation of buildings, cooling of urban environments, and greening dense urban areas. A crucial part of the project is to optimise the operational and maintenance regimes for each developed hybrid design, which include specification of application and resting periods as well as application flow rates, through controlled laboratory studies.

Figure 1. A living wall that has microclimate, thermal insulation and aesthetic functions, but cannot treat water (left). The proposed concept to the right adds treatment function to the green wall system.

These novel systems will be implemented in the field at a demonstration site and tested to verify the laboratory findings. To be able to assess the performance of these systems, mathematical models will be developed.

Outlook

Next steps are to rigorously apply and validate the developed wetland ecohydrological model using available vegetation, hydrological and nutrient data and running different flow and management scenarios. The coming years will see the development and modification of green walls to treat greywater and stormwater, but also tests of multi-functional hybrid green infrastructure in the field. The project will also develop adoption guidelines on the new technologies. At the end of the project by mid 2017, it is envisioned that short courses on the design of these hybrid systems will be offered in various Australian cities to increase their up-take.

About the Cooperative Research Centre for Water Sensitive Cities

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) brings together interdisciplinary research expertise and thought-leadership from Australia and the world to address current urban water management challenges facing our cities and regions. In collaboration with over 80 research, government and industry partners, it develops and synthesises knowledge into powerful tools and influences key players aiming to achieve sustainable, resilient and liveable water sensitive cities.

Further information

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