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Urban Stormwater Quality

Project 4.1: Stormwater quality pollutant sources, pathways and impacts

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Introduction and Background

Impacts from urban stormwater, both flow and water quality related, act to degrade receiving waters. This CRC project aimed to integrate the disciplines of science and engineering into stormwater management strategies by developing a suite of models for estimating stormwater pollutant loads from different sources areas, defining their impacts on aquatic ecosystems, and predicting the performance of stormwater management practices. The project aimed to package this into a Decision Support System (DSS) for stormwater managers.

Scientific Outcomes

This product has delivered an integrated decision support system for urban catchment managers to facilitate cost-effective strategies for improved urban stormwater quality and aquatic ecosystem health at the regional, catchment and sub-catchment scale. The Model for Urban Stormwater Improvement Conceptualisation (MUSIC – see www.toolkit.net.au/music) is an integrated tool that incorporates the findings from the two Urban Stormwater Program projects completed during 1999 -2003. MUSIC is made up of the following algorithms:

Rainfall-runoff model: The daily lumped model of Chiew (Chiew and McMahon, 1997; Chiew and McMahon, 1999) – which has an impervious store, and two pervious stores - has been disaggregated to run at timesteps of down to 6 minutes. The disaggregation allows the model to operate at the temporal scales appropriate for simulating stormwater treatment processes.

Stochastic pollutant generation: Pollutant concentration time-series are generated by a static or stochastic algorithm, with the user specifying event mean concentration and dry weather concentrations (along with standard deviation). Default values are provided by an exhaustive review undertaken by Duncan (1999).

Flow and pollutant routing: Drainage links between the nodes in MUSIC allow for straight 'pass-through', or user-specified routing (translation only, or Muskingum-Cunge routing).

Stormwater treatment processes: The primary breakthrough in MUSIC is the development of a Universal Stormwater Treatment Model (Wong et al., 2001) resulting from the research undertaken in CRC Project 4.2 'Stormwater Best Management Practices' during 1999-2003.

This model has demonstrated the effective use of a first-order kinetic decay algorithm (known as the "k-C*" model) to model pollutant decay through a treatment measure. Hydraulic behaviour within a treatment measure is modelled using the concept of continuously stirred tank reactors (CSTR), after the work of Persson et al. (1999).

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Pollutant characterisation and speciation undertaken as part of this project has provided useful insight to identify (a) typical particle size distributions of pollutants in urban stormwater (b) the association of contaminants with particle size ranges. Future work will use this to refine designs of stormwater treatment measures to achieve removal of target pollutants.

In addition to the research on the quality and treatment of urban stormwater, this project also made significant advances in the prediction of ecosystem response to urban stormwater management. Conducted in collaboration with the CRC for Freshwater Ecology, this project has delineated the importance of catchment imperviousness, and the nature of drainage infrastructure, in determining the health of aquatic ecosystems. Importantly, the research demonstrates that 'disconnecting' impervious areas from their receiving waters could significantly reduce their ecological impact

Application of findings

- The public release of MUSIC in May 2001 has fundamentally changed the urban stormwater management industry. It is now the standard method of assessing urban development proposals in Brisbane and Melbourne, and in several cases throughout Australia is being used to derive stormwater management guidelines. MUSIC is now used by over 350 licensed users worldwide – visit www.toolkit.net.au/music
- The project team has worked closely with Brisbane City Council (BCC) in the Brisbane River catchment to enhance whole-of-catchment understanding. BCC have used combined results from the Environmental Management Support System (EMSS) and MUSIC to support their decision-making framework for this catchment.
- Stormwater quality monitoring in Brisbane and Melbourne has improved the prediction of pollutant loads. This information has been utilised to improve the assessment of pre- and post-development pollutant loads in relation to catchment geology and land-use.
- Stormwater characterisation has informed the design of Stormwater Quality Improvement Devices (SQIDs), targeted to treatment specific pollutant types.
- Project work in the Yarra River catchment in Melbourne has supported Melbourne Water's integrated approach to catchment planning and prioritisation.
- Modules from MUSIC (e.g. the Universal Stormwater Treatment Model) are being made available for deployment to other models within the Toolkit (2003-2006).
- Water quality data from research undertaken as part of this project provides a useful resource for the application of the Catchment Modelling Toolkit.

References and further information

Further information on MUSIC is available from www.toolkit.net.au/music.

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