NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 135 MARCH 2005

A NOTE FROM THE DIRECTOR

Rodger Grayson

Inside...

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

SUCCESSFUL CRC TEAMS

As we launch into our last 100 days, the pace of delivery from our project teams is rapidly accelerating. The past two months have seen six new products and four updated releases on the Catchment Modelling Toolkit website, as well as new reports, papers and training activities. This pace will continue, building up to the crescendo of the Catchment Modelling Schools in Brisbane and Sydney from late June and into July. This frenetic activity over a sustained period can only occur because we have, in the words of our reviewers last year, "highly skilled, innovative and dedicated teams..." But there is more to teams than just these attributes and as we head towards a larger, more complex form of CRC in eWater, it is timely to reflect on what attributes have made our teams successful and where we might be able to improve.

Last year as part of the preparation for the eWater Business Case, our CRC's Executive team listed key attributes of our project and program teams that we believed were central to successfully delivering on our mission, and which may be useful background for establishing effective teams in the eWater CRC.

The key team attributes we identified were:

- Clearly stated and consistent goals, agreed to by all team members
- A commitment to working in multidisciplinary teams, often across wide geographic ranges
- Technical breadth and depth, including a mix of experience, from graduate students to experienced industry members
- A high level of mutual respect for the full range of skills required
- Understanding of and connection with industry (appreciation of the operating environment for industry)
- Strong operational and strategic leadership

The CRC for Freshwater Ecology undertook a more thorough analysis, using consultants who specialise in effective team performance. That review identified seventeen key attributes, grouped under four headings of Leadership, Resources, Dynamics and Processes. Interestingly most of the attributes we identified above come under the Leadership and Resources clusters. The Dynamics and Process clusters include attributes such as trust, goodwill and creative dialogue. These are clearly critical foundations for effective teams, but we had taken them for granted in our simple analysis. This omission may indicate that we have become blasé about these vital components, having experienced many years of successful collaboration. But these are important foundations that have taken time to develop, and if we were to look a little deeper, still dominate the relative performance of our teams.

In moving to the eWater CRC we will be bringing together two large groups with partially overlapping relationships, as well as several new Participants. The eWater CRC will also be dealing with a wider range of issues, a more complex operating environment and will be wanting to "hit the ground running" when it kicks off later in the year. All this indicates that careful attention will need to be paid to building new teams, taking into account the expanded range of individual skills, the wide body of knowledge about attributes of successful teams, and our collective experience.

Of course we are building on the very successful base of two CRCs, each of which has approached the task of delivering the outcomes of high quality research to meet industry needs in somewhat different ways. In our CRC, individual teams tend to cover the full spectrum of skills required to go from industry need, to research output, to practical tool. The scope of our work has enabled this approach while still maintaining workable team sizes. In the CRC for Freshwater Ecology, a different approach is more common, where there is some splitting of these functions. Their Knowledge Broker approach has been used very successfully, with specific teams dedicated to using research outcomes to deliver industry needs.

The experts say teams of somewhere between two and twenty five is about right, with around ten being a common factor for success. Teams must be large enough to span the skills and roles required, but small enough to work in pursuit of a common goal, without the transaction costs of communication and planning consuming all of the project resources. The expanded challenges of eWater will inevitably push us to deal with more complex problems. There is also a considerably expanded set of individual skills and experience across the eWater CRC. This does not necessarily mean larger teams. The proposed structure of eWater can enable

CRC PUBLICATIONS LIST

For a complete list of all available CRC publications please visit www.catchment.crc.org.au/catchword

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team sizes to stay manageable and will involve some splitting of functions across the areas of research, products and commercialisation and adoption.

Existing joint activities, and the terrific atmosphere that has surrounded the development of the eWater CRC to date, augers well for the development of successful teams. The Participants bring a wide experience of different team models, an amazing breadth and depth of skills, and a solid history of working together. The challenge will be to develop effective and efficient teams with their own eWater culture, something that will not happen immediately, or by osmosis. This will be an ongoing task that has already begun and will continue over the coming months as the new eWater CRC takes shape.

In the meantime, the 'finals fever' in our CRC will continue as our teams deliver on an extremely ambitious schedule, drawing on all those attributes that have brought us to this point.

We look forward to the successful completion of our last 100 days, and, as with any team, the end of season party!

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leaders
GEOFF PODGER & ROB ARGENT

Report by Rob Argent

Integrating Component Models with E2

New release of E2
E2, a catchment modelling software product, was recently released in a beta version on the Toolkit website (www.toolkit.net.au).

This E2 version is underlain by an elegant and robust conceptual structure developed primarily to support a flexible range of modelling approaches through integration of alternative component models.

To examine the variety of approaches to the component model integration available or being developed in E2, five examples taken from CRC for Catchment Hydrology Research Program 2 are examined.

The component models from each of the Program 2 projects are:

- 2A – irrigation area behaviour
- 2B – catchment sediment prediction
- 2C – salt modelling
- 2D – denitrification by riparian zones
- 2E – flow effects of land cover change

Each of these has a different method, approach or requirement for E2 integration.

Structure of E2
Before discussing the integration issues, firstly some background on the structure of E2.

E2 is a node-link style system, with generation and filtering of flow and material taking place in sub-catchments, from where they pass directly to a node before being routed and possibly processed along links (Figure 1.1). E2 sub-catchments are further divided into areas with a common response or behaviour ("Functional Units" – FUs) based on various combinations of land use/cover, management, position in landscape, and/or hazard.

The major components of the model in each sub-catchment are broken into options related to the following processes (Figure 1.2):

- runoff generation,
- constituent generation
- filtering

Representing sub-catchment behaviour by these three processes enables a "menu" of different algorithms to be available for each process in each functional unit in each sub-catchment, delivering the resulting flows and loads to the sub-catchment node.

From a node, the flow and material pass through the catchment network via a series of links and nodes to the catchment outlet/s. Processing and management of material and flows along links includes routing, storage, source and sink, and enrichment and decay processes.

Component Models
Fitting the component models from CRC for Catchment Hydrology research projects into this structure requires a variety of different approaches.

2A Irrigation Area Behaviour
The irrigation component model will be integrated into E2 by having the irrigation model act as a constituent generation model positioned in a FU in E2. In addition to normal FU requirements, the irrigation model will require an available water inflow from upstream in response to a water order. Outputs will include flow and salt load from the irrigation area. Details for operating the irrigation model are given in the Program 2 report in this month's *Catchword.*

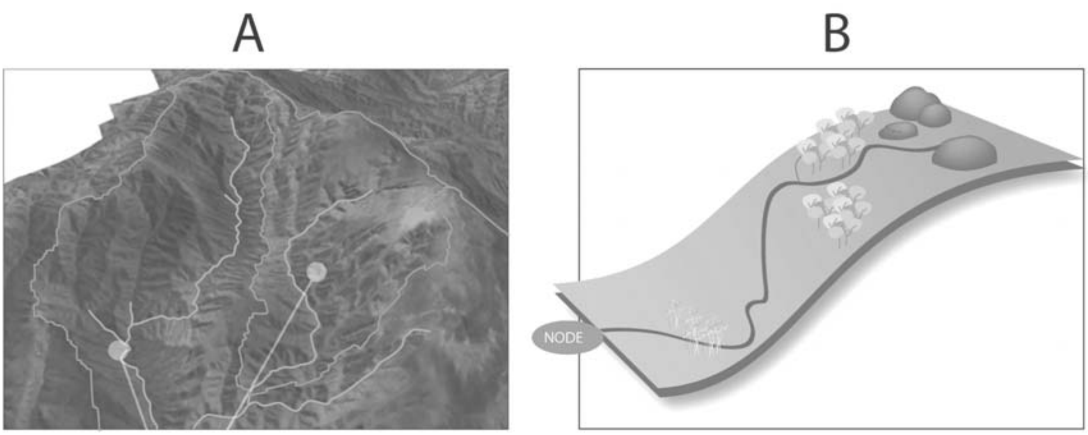

Figure 1.1: E2 Structure – Sub-catchments and nodes

CATCHMENT MODELLING SCHOOL 2005

BRISBANE
30 June - 8 July 2005
at Griffith University

SYDNEY
14 - 22 July 2005
at the University of Sydney

Following the success of the Catchment Modelling School held in Melbourne last year, the CRC for Catchment Hydrology is planning similar events in both Brisbane and Sydney during July 2005.

We are now calling for participants to register their interest in specific workshops to assist us in developing a schedule from over 30 possible courses.

As an incentive, people who express interest before 7 April 2005 will be given the opportunity to ensure their workshop place in advance of a general call.

You can obtain further information and register your interest now by visiting http://www.toolkit.net.au/school

NEW TECHNICAL REPORT

Erosion in Forests: Proceedings of the Forest Erosion Workshop - March 2004

by

Jacky Croke
Ingrid Takken
Simon Mockler

Technical Report 04/10

The material in this report is the product of a three-day workshop on Erosion in Forests held in Canberra during March 2004, the third in a series of documented workshops over the last ten years.

The aim of this workshop was to draw together participants in forest research, management and environmental conservation to discuss scientific findings, implications and key issues for sustainable management. This was achieved through formal presentations, field-group discussions and experimental demonstrations.

The collection of papers in this volume represents a collection of research in the major areas of forest management and incorporates the diverse range of forest management themes including water quantity, quality, fire management and sustainability that are taking place in forest research presently.

Bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au/publications

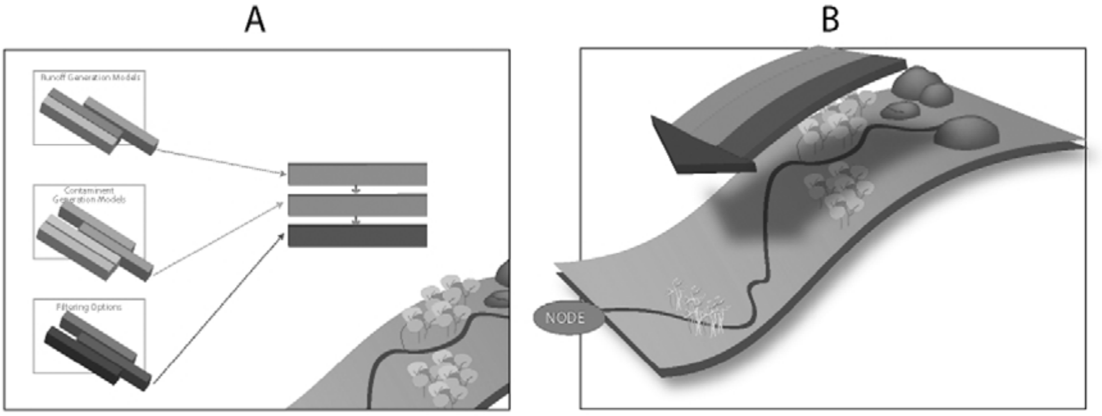

Figure 1.2: E2 Conceptual structure of sub-catchment options for runoff generation, constituent generation and filtering

2B Catchment Sediment Prediction

Average annual sediment loads from the SedNet model are integrated into E2 through use of a component model that disaggregates SedNet results to a daily timestep using an observed concentration rating curve. SedNet produces sediment loads for each link in a network, so E2 will reflect or load a Sednet network. The disaggregation model will then work though a link-by-link process, with the capability to scale sediment concentrations from nodes with observed concentrations to un-monitored nodes.

2C Salt Modelling

Various range of options for integrating the salt modelling methods from project 2C into E2 have been explored, and will be developed in a number of stages. The first stage is a straightforward process where salt modelling is undertaken using an existing EMC (Event Mean Concentration)/ DWC (Dry Weather Concentration) model. In this model, different parameters are used to represent the concentration of a constituent (in this case, salt) in dry weather baseflow and in surface runoff during rainfall events. A second stage approach involves importing a network, loads and flows from the 2C stand-alone model, and using these to run an E2 catchment model.

2D Denitrification by Riparian Zones

The riparian denitrification component model developed by Project 2D fits directly into E2 as one of the filter options. The filter estimates three processes of nitrate mass removal in riparian buffers from 1) perched surface water in ephemeral stream floodplains, 2) perennial stream root zone interception of groundwater, and 3) perennial streams bank storage of surface water.

2E Flow Effects of Land Cover Change

Project 2E has investigated the effects of land-use change on daily flow duration curves (FDCs) and has produced a toolkit product for modifying FDCs on the basis on forest cover. Operation of this product alongside the Rainfall Runoff Library (RRL) allows rainfall runoff models to be calibrated against FDCs for different land use combinations, thereby enabling daily time series to be estimated. In E2, these changed time series can be either directly loaded into a FU, or the rainfall runoff model for a given FU can be re-parameterised to reflect the flow duration changes.

Next Steps

These examples cover some of the ways in which component models covering a diverse range of science can be integrated with E2. As E2 develops and new integration challenges arise, the range of available methods will also be expanded to meet the challenges.

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PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER WALLBRINK

Report by Scott Wilkinson

2B update – New features, training, and model uptake

Sednet Releases

August 2004 was the last *Catchword* issue to describe the happenings in Project 2.20 (2B): 'Sediment and nutrient budgets for modelling water quality in river networks'. Joel Rahman, Tim Ellis, Harold Hotham and I then described the central goal of the project to deliver SedNet as catchment modelling toolkit software, to provide catchment managers with the ability to model sediment movement at whole-of-catchment scale. SedNet is well suited to help determine priorities for management activities and set end-of-valley sediment load targets.

Since last August, Harold Hotham, Yun Chen and I have made three SedNet releases (www.toolkit.net.au/sednet), and the product has moved from its initial beta-release status. With Joel Rahman's help, a round of software testing has been successfully completed, including improvements to software stability. The testing was time consuming, but has really paid off in model usability and confidence in the model outputs.

Contributor module

Several features have been added to the software as part of these releases. These include a contributor module, designed to help managers reduce suspended sediment export. The module calculates the delivery of sediment through the network, accounting for the losses of sediment to reservoir and floodplain deposition. These losses can mean that sediment eroded in some areas of the catchment is unlikely to make it to the catchment outlet, and action can be targeted to areas of the catchment most contributing to export. Figure 2.1 shows the pattern of contribution for the upper Goulburn catchment. Areas downstream of the reservoir contribute higher amounts of suspended sediment per hectare (darker shades) to the catchment outlet. Most of the sediment from areas upstream of the reservoir is trapped in the reservoir.

Next releases

There will be at least two more SedNet releases before the Catchment Modelling School in June 2005. The first, due shortly, will mainly provide usability improvements including the ability to specify gully erosion rate. It will also include more link attributes to help target high erosion rates on a per hectare basis.

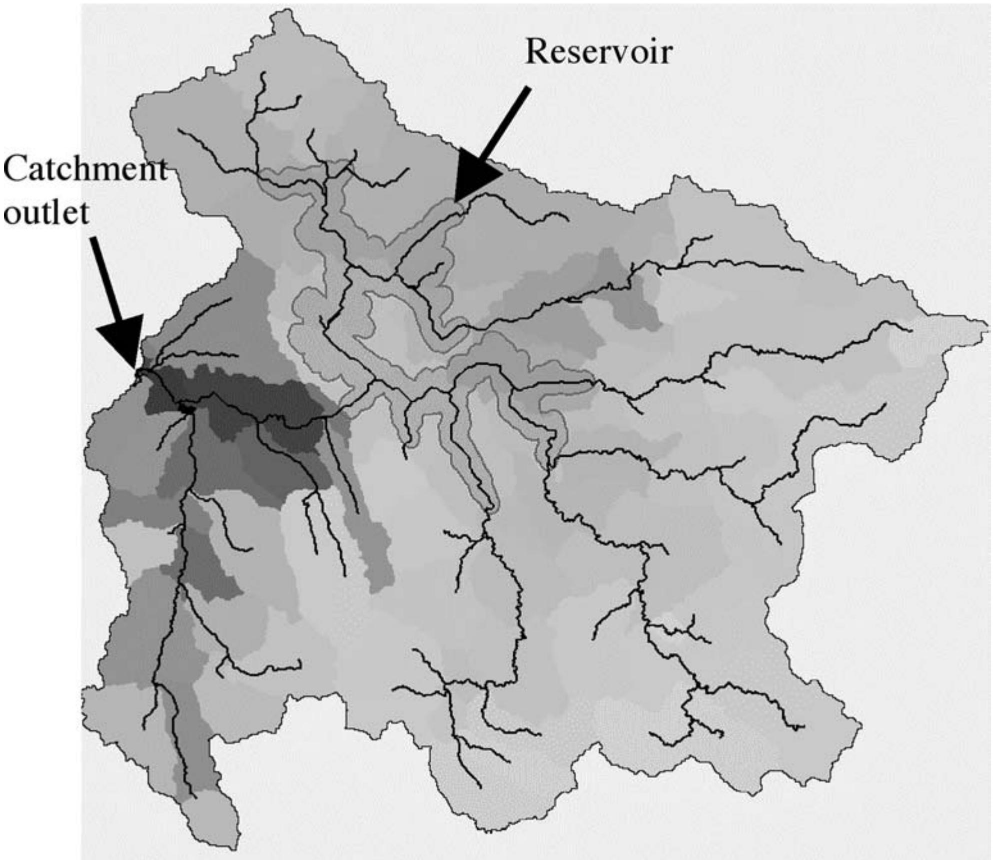

Figure 2.1: Contribution pattern for Upper Goulburn Catchment

NEW TECHNICAL REPORT

CLASS – Catchment Scale Multiple Land-use Atmosphere Soil Water and Solute Transport Model

by
Narendra Kumar Tuteja
Jai Vaze
Brian Murphy
Geoffrey Beale

Technical Report 04/12

CLASS is a distributed, eco-hydrological modelling framework that deals with water and solute movement from hillslope to catchment scale. This report describes the modelling framework, CLASS, which is at the more complex end of the modelling spectrum, but where there has been a major effort made to exploit the ever-increasing range of available data for setting up and running the model.

Three CLASS products are now available through the Catchment Modelling Toolkit at www.toolkit.net.au/class

Bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au /publications

SERIES ON MODEL CHOICE

The Model Choice series is designed to assist you to better understand catchment modelling and model selection. The first publication entitled 'General approaches to modelling and practical issues of model choice' is enclosed with this month's edition of *Catchword*

The second in the series entitled 'Water quality models – sediment and nutrients", is now available for downloading from the Catchment Modelling Toolkit web site at http://www.toolkit.net.au/modelchoice

A printed copy of the second publication in the Model Choice series is included with this month's *Catchword*.

Additional printed copies can be obtained by contacting Virginia Verrelli at the Centre Office.

A second release is scheduled for June 2005. The June release will contain:

- A module for disaggregating results to investigate temporal patterns of sediment delivery. (Geoff Davis is coding this module, which takes the approach that it is best to predict the temporal patterns using low-flow and event observations of sediment concentration. These observations help to describe the dynamics of sediment supply and transport within the catchment. This avoids the need to predict the daily movement of fine sediment through catchments, including sediment generation, transport, temporary storage and re-entrainment. There are currently very little (almost no) data on which to explicitly represent these processes over short periods).
- A dynamic bedload sediment budget that better predicts the location of sand slugs
- Support for grid tiling to allow large catchments to be modelled at high resolution
- An improved land-use change tool
- Improved mapping features including a wider selection of colour schemes
- Ability to export SedNet results to E2

Related project work

In an Associated/Additional project with Natural Resources and Mines, Qld, the development of a module to build nutrient (Nitrogen and Phosphorus) budgets of river networks will continue after the CRC for Catchment Hydrology winds up.

Other activities

The project team has also been involved in helping the CRC's Development Projects get their SedNet modelling underway. In the Murrumbidgee focus catchment and all the Great Barrier Reef catchments, SedNet models are being used to help set priorities for management actions and establish sediment reduction targets. The interest in the recent SedNet training, associated with the Hydrology and Water Resources Symposium, is encouraging for the continued uptake of the model. The workshop participants were quick to grasp the fundamentals of the approach, and learnt the importance of correct model parameterisation.

So now it's down to the business of completing implementation of the planned features.

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PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by John Tisdell

A preliminary analysis of alternative water market structures

As outlined in the last *Catchword* article, there are two main types of water auction structures operating in Australia:

- call auction structure
- double auction structure

The call auction structure, as the name suggests, involves those wishing to buy or sell water entitlements to submit an offer to a central clearing house until the call (close). The double auction structure is more commonly known and allows buyers and sellers trade in real time with each other. Part of the research in Project 3.09(3A): 'An evaluation of permanent water markets' has been to explore the relative merits of these water auction structures in the focus catchments. This article gives a brief overview of the findings of a series of pilot experiments conducted using data from the Goulburn Broken catchment. The research questions evolved around the relative merits of the various auction structures.

Research questions

The literature is somewhat divided on the relative merits of open call (where the bids are made publicly available after the call), the closed call (where the bids are never made public) and double auctions. In some studies, the call and double auctions are found to be equally efficient in allocating the available resource. In others, the double has been found to be superior. These studies were conducted to draw generic conclusions, and as such, in most of the studies, only single units of an unidentified commodity are traded and the players have defined roles as buyers or sellers.

Our work uses contextualised environments and actual hydrological economic data from the catchments. Traders can sell multiple units (or single if they choose) and can be buyers and/or sellers according to the water market conditions.

The primary research question is none the less the same: Is a call market equally efficient in distributing the resource as a double auction? The prior expectation is that as information improves so the efficiency of the market should also improve. In other words, the relative efficiency of the markets should be double auction, open call auction and closed call auction in that order.

The experimental environment

In the experiments, each participant managed the crops and water usage at a node and was paid in cash according to how much farm income is made. Twenty years of crops and trading were experimentally simulated under each type of auction structure. The experiments were conducted using the CRC for Catchment Hydrology's Mwater computer package. These results are somewhat preliminary as they are based on only one replicate of 20 years for each auction structure.

Over the last few years, REALM has been adopted as the modelling standard for water resource planning and management in Victoria, and is the key tool for reviewing and quantifying water entitlements for water authorities within that State. It is for this reason that the nodes used in the REALM model for the Goulburn-Broken Catchment were considered to be appropriate for use in the current study.

The ten nodes used were Rodney, Tongala, Rochester East, Rochester West, Shepparton 2, Shepparton 8, Boort, Deakin, Upper Goulburn and Tandara. For the purpose of the study, data from each node was

Table 3.1. Summary data from the various auction structure experiments.

	OPEN CALL AUCTION	Closed Call Auction	Double Auction
Number of Trades	138	139	335
Average Price Sell Bids ($)	52.47	57.63	62.08
Average Price Buy Bids ($)	70.87	65.62	57.08
Av. Quantity Sell Bids (ML)	195	125	81
Av. Quantity Buy Bids (ML)	496	492	217
Average Market Price ($)	60.25	65.6	60.07
Average Quantity traded (ML)	1131.35	876.3	1201.25

NEW TOOLKIT PRODUCTS

Over the last couple of weeks a number of new Catchment Modelling Toolkit products have been released including:

IHACRES - a catchment-scale rainfall-streamflow modelling methodology whose purpose is to characterise the dynamic relationship between rainfall and streamflow, using rainfall and temperature (or potential evaporation) data, and to predict streamflow
www.toolkit.net.au/ihacres

E2 - a software product for whole-of-catchment modelling. It is designed to allow modellers and researchers to construct models by selecting and linking component models from a range of available choices. E2 enables a flexible modelling approach, allowing the attributes and detail of the model to vary in accordance with modelling objectives
www.toolkit.net.au/e2

AQUACYCLE - a daily urban water balance model which has been developed to simulate the total urban water cycle as an integrated whole and provide a tool for investigating the use of locally generated stormwater and wastewater as a substitute for imported water alongside water use efficiency
www.toolkit.net.au/aquacycle

For further information about the Catchment Modelling Toolkit visit www.toolkit.net.au

NEW TECHNICAL REPORT

Water Farms: A Review of the Physical Aspects of Water Harvesting and Runoff Enhancement in Rural Landscapes

By
Laura Richardson
Peter Hairsine
Timothy Ellis

Technical Report 04/6

Water farming is an approach to the problem of managing the quantity of water input to our streams, and is an idea that has been around for thousands of years. In this concept, land managers are able to generate more runoff for a given amount of rain than would happen in normal circumstances. Historically, most examples focused on providing extra water from a farm for use on the same farm. However, there are considerable prospects for 'water farms' enterprises that use water harvesting techniques to provide additional water into the river system and new water markets. It is these prospects that have prompted this review.

Bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au/publications

amalgamated to form a single virtual 'farm' with a water allocation and a number of crops that were available to be grown. Actual node allocations were divided by 100, and marginal values for each crop were divided by 4, in order to make the numbers more manageable for experimental participants. Characteristics of each node, or farm, included: available crops; marginal values for each crop; and maximum water use for each crop. Water entitlements for each farm in this case were set at 55% of the full allocation.

For the sake of simplicity, six different crop types were used to represent overall crop production in the region. Crop types used were: annual pasture, perennial pasture, lucerne, orchard, winter cereal and summer cereal. Players were not made aware of either the name of their irrigation area, or the crop types available to them; rather, numbers were used to represent both farm and crops.

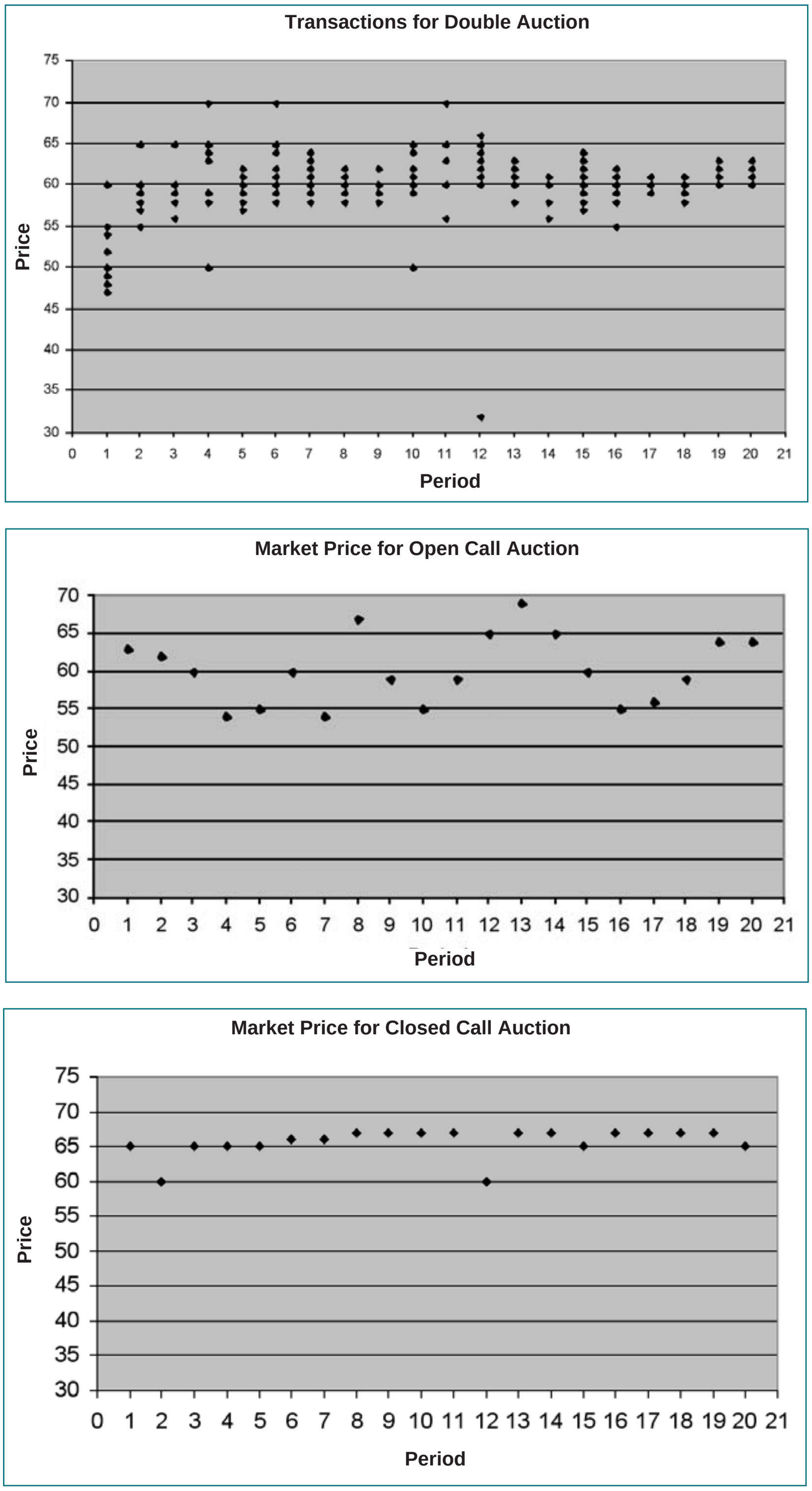

Figure 3.1. Transaction prices through time

The experiment involved recruiting students from across the university campus to act as farmers trading water. The students were given detailed instructions and were required to complete a quiz to ensure they understood the experiment beforehand. Copies of the instructions and quiz are available on request.

Results

A number of criteria have been used to judge the efficiency of auction structures. The measures of efficiency used in this preliminary study of one replicate of 20 years for each auction structure include convergence of prices and quantities to the competitive equilibrium.

The basic trade information is presented in Table 3.1. The key results are:

1. The volume offered for sale is smaller in the double auction, compared to the call auctions and the open call sell quantities are higher than the closed call sell quantities.
2. The average price of the open call and double auction were close to the competitive equilibrium of $59.75 with the average market price higher in the closed call than in either the open call or double auction.
3. Unexpectedly, the differential between the average bid price and average sell price was greatest in the open call. The differences were $18 ($52.47 – $70.87) in the open call compared to $8 ($65.62 - $57.63) in the closed call and $5 ($62.08 - $57.08) in the double auction experiment.
4. The quantity traded in the closed call was lower than in the open or double auction experiments. On average, 125ML was offered for sale in a closed call compared to 195ML in the open call market experiments.

Convergence to competitive equilibrium

In the vast majority of cases in the real world, traders do not instantly converge to a competitive equilibrium. It often takes some time for traders to gain an understanding of the dynamics of the water market and formulate appropriate strategies. The time it takes for traders to converge on a competitive equilibrium is a measure of market performance.

Figure 3.1 shows transaction prices through time for the three auction structures. In the case of the double auction there was a general convergence around the competitive equilibrium. Some outliers occurred in periods 4, 5 and 12. The open call showed fluctuating prices and some movement toward stability in the final periods. In contrast to the open call, the closed call shows strong convergence, all be it to a price higher than the competitive equilibrium level.

Convergence of quantity traded

The market is expected to reallocate the available water to its most profitable use. In the case of the open and double auction structures the average volume traded approached the optimal (1131.35ML in the open call; 1201.25ML in the double; optimal 1284ML). The closed call experiment fell well short of the mark in terms of redistributing the available water resource with only 876.3ML on average traded.

Conclusions

The results presented here are preliminary and require further replication to be statistically analysed. The preliminary results, however, do show differences between the auctions structures that warrant further consideration.

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TOOLKIT SOFTWARE

WRAM

WRAM is a software application to simulate water allocation and trading between irrigation areas.

The Water Reallocation Model (WRAM) is a Windows application to simulate water allocation and trading between irrigation areas. Based on an economic optimisation model, WRAM can be integrated with hydrologic network models for assessing water resources management plans.

In addition, WRAM performs standard input-output analysis, and integrates input-output accounts in value terms with water accounts in physical units to assess the impact of water reallocation on regional economy.

You can find out more about WRAM and download the software from the WRAM web site: http://www.toolkit.net.au/wram

NEW MUSIC SOFTWARE - VERSION 2.1

MUSIC Version 2.1 is now available for downloading from the Catchment Modelling Toolkit website at http://www.toolkit.net.au/music

We recommend all registered MUSIC users log in as a Toolkit member, download the Version 2.1 MUSIC software installer and release notes, run the installer file and enter their user registration code to access the Version 2.1 software.

MUSIC Version 2.1 corrects an error in the algorithms that predicted Total Phosphorus (TP) and Total Nitrogen (TN) removal through the filter medium of a bioretention system. It also corrects an occasional error with flow mass-balance calculations in treatment systems, which occurred under unusual circumstances (usually when outlet sizes were very small).

Further details about the impact of this error are available in the release notes on the download page.

Visit www.toolkit.net.au/music

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader TIM FLETCHER

Report by Belinda Hatt, Nilmini Siriwardene, Ana Deletic and Tim Fletcher

Filter media for stormwater treatment and recycling: the influence of hydraulic properties of flow on pollutant removal

Introduction

Runoff from urban areas is one of the leading causes of water quality degradation in surface waters (U.S. Environmental Protection Agency 2000). At the same time, the use of water is approaching, and in some cases exceeding, the limits of sustainability in Australia. As a result, there is an increased recognition of the need to utilise stormwater runoff for non-potable requirements, thus reducing demand on potable resources. However, water recycling is not yet widely practiced in many places, particularly with respect to general urban runoff. This is largely due to a paucity of technologies for reliable and affordable on-site treatment of stormwater runoff which can guarantee water quality fit for its intended use.

Stormwater filtration systems are flexible and effective structural stormwater pollution control measures. However, there are two major issues that need to be resolved before these systems can be reliably implemented as part of a stormwater recycling system:

1. current design is not tailored to treat stormwater to the consistently high standards required for safe water use; and
2. whilst eventual clogging of filters is inevitable, designs must be able to prevent premature clogging, so that filters can perform adequately over an acceptable lifespan.

Clogging is a process common to all types of water filters and occurs because sediment is deposited in the filter as water percolates through the filter. These deposits build up over time, decreasing porosity and ultimately preventing water from passing through. Clogging has been identified as the primary cause of premature failure of stormwater infiltration systems (Lindsey, Roberts *et al.* 1992). However, although clogging decreases the hydraulic capacity of a filter, it is possible that clogging may actually improve stormwater treatment efficiency, since lower flow rates lead to increased detention time. Preliminary findings with respect to the effect of clogging on stormwater pollutant removal efficiency in conventional stormwater filter media are presented below.

Methods

A fully automated, one-dimensional (1D) experimental rig was used to assess the performance of conventional biofilter media for different flow rates and wetting conditions. The filter consisted of a 90 cm layer of gravel (as used in conventional infiltration systems) over a 70 cm soil layer (or sand with the same hydraulic conductivity). Stormwater was introduced through a rotating sprinkler system, at a rate controlled by software and pressure sensors. Outflow from the system was monitored using a tipping bucket rain gauge.

Synthetic stormwater was used for testing, and was prepared using sediment collected from a local stormwater retarding basin. A slurry of the <300mm fraction (to reflect pre-treatment for coarse solids removal) was added to a tank of tap water in known amounts to achieve suspended solids concentrations typical for Melbourne stormwater (Duncan 1999). Nutrient and heavy metal concentrations were topped up as required using chemicals.

Five experiments have been conducted, each with a different hydrologic regime (Table 4.1). Either a constant water level was maintained in the gravel layer or was varied between the top and bottom of the gravel layer. Each experiment was run until the system was clogged (outflow was 10% of the initial outflow).

Water samples were collected on alternate days at the inflow, outflow, interface between the two filter media, and various other points through the filter media. These were analysed for total suspended solids (TSS), total phosphorus (TP), total nitrogen (TN), ammonia (NH3), dissolved phosphorus (FRP), nitrate/nitrite (NOx), and total dissolved nitrogen (TDN) using standard methods. Heavy metals were also analysed, but are not discussed here.

Results and discussion

• Changes in water quality through the filter media

Sediment levels in incoming stormwater rapidly decreased in the upper section of the filter, regardless of the hydrologic regime. This is illustrated in Figure 4.1, which presents the change in sediment concentration with depth. Particulate-associated pollutants (TP, TN and heavy metals) followed a similar trend. In contrast, FRP and NOx largely passed through the filter, with little to no reduction in concentrations. Ammonia behaved quite differently, with increasing outflow concentrations as each test progressed.

Table 4.1. Experimental conditions

	Filter media	Stormwater	Water Level		Flow (l/day)		mean k (m/s)
				depth below surface (cm)	initial	final	
E1	gravel on soil	sediment + tap water	constant	45	34.6	3.5	8 x 10-6
E2	gravel on sand	sediment + tap water	constant	45	130	38.9	3.25 x 10-5
E3	gravel on sand	sediment + tap water	constant	85	104	32.8	3.95 x 10-5
E4	gravel on sand	sediment + pond water	varying	5 - 85	51.8 – 104	6.0 – 14.7	3.3 x 10-5
E5	gravel on sand	sediment + tap water	varying	5 - 85	60.5 - 130	46.7 - 130	3.28 x 10-5

• Changes in water quality with time

Gravel. Inflow concentrations of suspended solids fluctuated between 75 and 185 mg/l (E2 results), due to mixing variations in the dosing tank, however outflow concentrations from the gravel filter were steadily less than 10 mg/l (Figure 4.2). Outflow concentrations of total nitrogen were also steady, despite variable inflow levels. Total phosphorus outflow concentrations followed a similar, but significantly reduced, pattern to inflow levels. Despite fluctuations in TSS concentrations, both within and between experiments (overall range: 75-255 mg/l), outflow TSS levels were consistently below 10 mg/l.

Sand. Pollutant outflow concentrations from the sand filter closely tracked the trend in inflow concentrations (Figure 4.3). However, it must be noted that the incoming water had already filtered through the gravel layer, thus pollutant concentrations and the particles entering the sand were much smaller, both of which will influence relative reductions in pollutant concentrations. While the sand removed some sediment and phosphorus, it had little effect on nitrogen levels. This may be explained by the fact that most particles have already been removed prior to filtering through the sand, so the incoming TN is more likely to be in dissolved form. Dissolved pollutants are removed by processes such as adsorption and biological activity, which are not promoted by either sand or gravel.

The maximum flow rate occurred on the first day of each test and steadily declined before levelling at a minimum flow (due to clogging). Surprisingly, this flow reduction (and resulting increase in detention time) did not have any discernible influence on outflow concentrations of TSS, TP or TN.

• Pollutant removal efficiency with clogging of the filter media

Pollutant removal efficiency was reasonably steady for the duration of each experiment. The suspended solids removal efficiencies of the gravel and multi-filters did not change (average EFF = 0.93 and 0.98), while some variation in the efficiency of the sand filter (average EFF = 0.78) was evident. For all three filter types, there was a slight decrease in TN removal efficiency with time, while the efficiency of TP removal slightly increased with time. The likely reason for the increase in TP removal efficiency is that bound phosphorus is mainly associated with smaller particle sizes and as the filter clogs, it is able to trap smaller particles.

Dissolved phosphorus and nitrate/nitrite concentrations were not reduced by the gravel, sand or multi-filters. However, the soil filter used in the first test consistently removed almost all nitrate/nitrite. In contrast, significantly elevated levels of dissolved phosphorus were observed in the outflow. Although this remained significant for the duration of the experiment, outflow

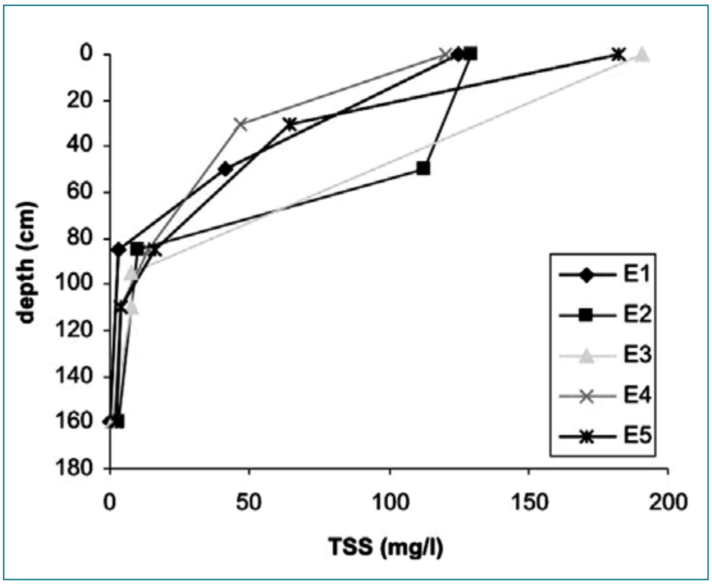

Figure 4.1. Depth profiles for suspended solids through the column

CATCHMENT MODELLING SCHOOL 2005

BRISBANE
30 June - 8 July 2005
at Griffith University

SYDNEY
14 - 22 July 2005
at the University of Sydney

Following the success of the Catchment Modelling School held in Melbourne last year, the CRC for Catchment Hydrology is planning similar events in both Brisbane and Sydney during July 2005.

We are now calling for participants to register their interest in specific workshops to assist us in developing a schedule from over 30 possible courses.

As an incentive, people who express interest before 7 April 2005 will be given the opportunity to ensure their workshop place in advance of a general call.

You can obtain further information and register your interest now by visiting http://www.toolkit.net.au/school

TOOLKIT DATA PRODUCT

Soil Hydrological Properties for Australia

The first Catchment Modelling Toolkit data set has been released on the Catchment Modelling Toolkit website.

Soil Hydrological Properties for Australia (SHPA) provides continental coverage of soil properties relevant to catchment Modelling. This data set can be downloaded from www.toolkit.net.au/shpa

The data set provides estimates of twelve properties in total along with information on the uncertainty of the property estimates.

Further details of the data set development and its limitations are available in the data set documentation at www.toolkit.net.au/shpa

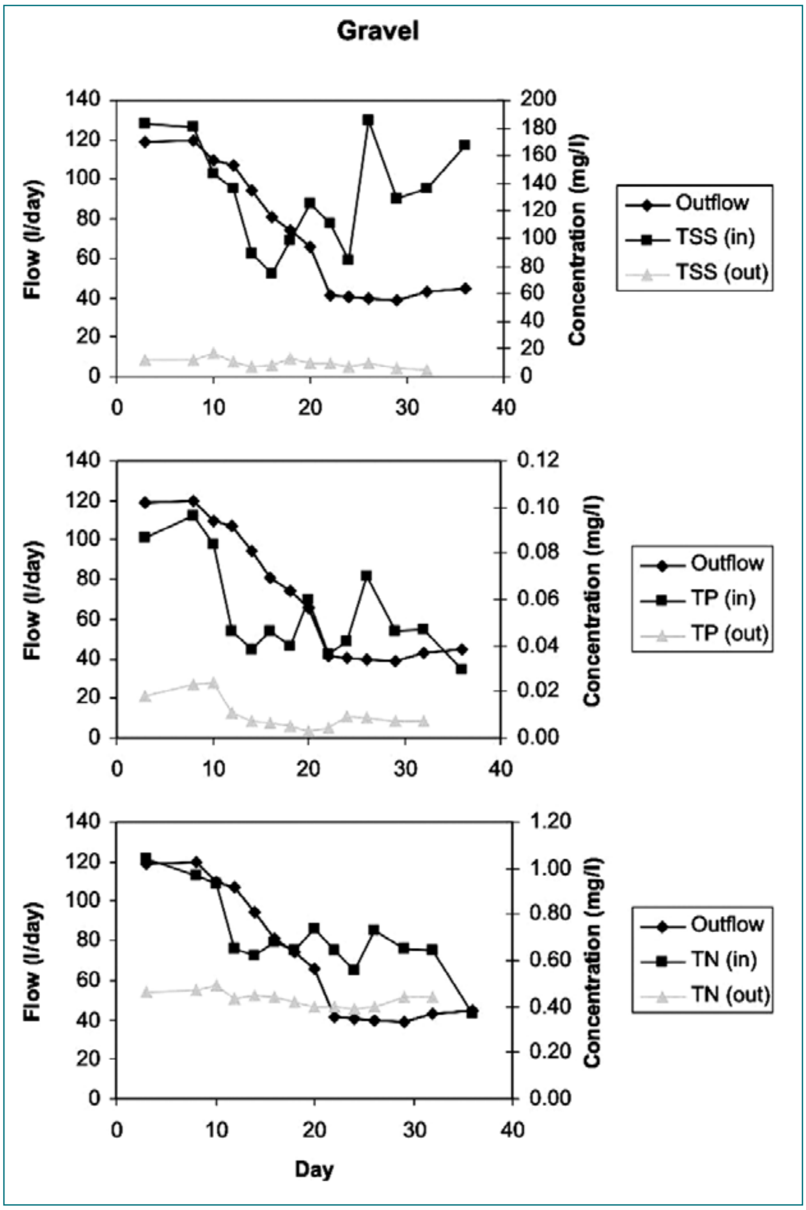

Figure 4.2. Inflow and outflow pollutant concentrations and flow rates in a gravel filter (Note: results are for E2 but are reflective of all tests)

It is suggested that as flow decreases and the filter becomes dirtier, release of previously trapped pollutants may become a more important process. This is possible because there are more pollutants in the filter and more time for transformations and/or remobilisation to occur.

Conclusions

Both the gravel and multi-filters were highly efficient at removing suspended solids and particulate-associated pollutants. This removal efficiency was consistent, even as the filters became clogged. Removal of dissolved nutrients was more variable, with little reduction in concentrations overall. The exceptions to this trend are ammonia, which was present at elevated levels in the effluent from all filters; dissolved phosphorus, which was released from the soil filter; and nitrate/nitrite, which was almost entirely removed by the soil filter.

concentrations slowly decreased, suggesting that this was due to release of phosphorus already present in the soil media. Elevated outflow concentrations of ammonia were also observed for all filters, and increased with time. This implies that other forms of nitrogen trapped by the filter are being transformed to ammonia, particularly as the flow (and probably oxygen) decreases. It is likely that this is due to mineralisation of particulate organic nitrogen, yet it is surprising that denitrification is not evident (it would be expected to occur in tandem); perhaps this is the result of using tap water that does not contain bacteria to make up the stormwater (which may also be precluding the earlier step of nitrification from occurring).

Flow does not influence pollutant removal efficiencies until the minimum flow is reached i.e. the system is clogged. At this point efficiency becomes variable.

Although preliminary, these results challenge the concept that increased detention time improves the treatment performance of infiltration systems. The experimental data demonstrated that increased detention time as a result of clogging did not enhance pollutant removal efficiency (with the exception of dissolved copper).

These results have implications for stormwater filtration systems in terms of treatment performance. The importance of preventing clogging to maintain its hydraulic capacity the of stormwater filters is well accepted, but some clogging may be desirable if clogging was found to improve the pollutant removal efficiency of the filter. However, the experimental data presented in this paper suggests that clogging does not improve removal efficiency, and so prevention of clogging remains essential to extend the life of stormwater filtration systems in terms of hydraulic capacity and treatment performance.

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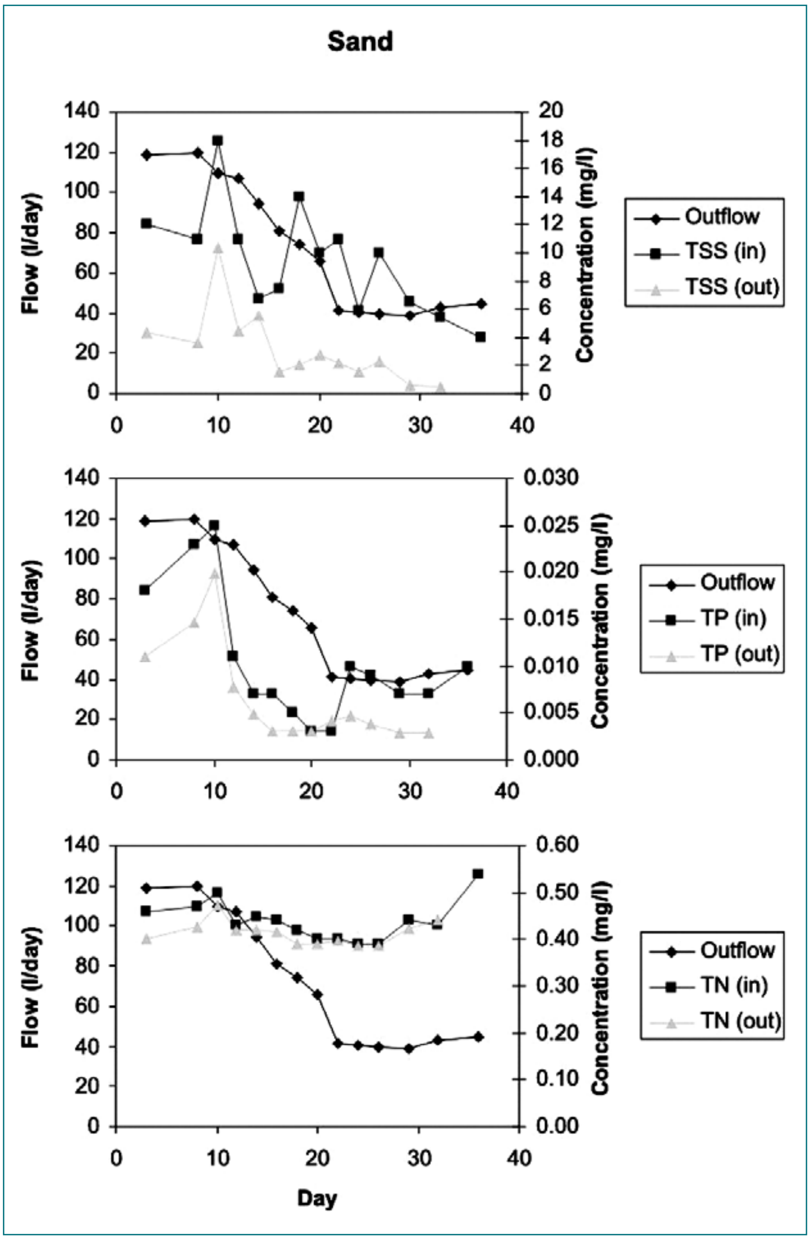

Figure 4.3. Inflow and outflow pollutant concentrations and flow rates in a sand filter (Note: results are for E2 but are reflective of all tests)

FRESHWATER ECOLOGY REPORT

Urban Stormwater and the Ecology of Streams

By

Chris Walsh
Alex Leonard
Tony Ladson
Tim Fletcher

Technical Report 05/4

This CRC for Freshwater Ecology Technical Report explains why urban stormwater degrades the ecological condition of urban streams, during dry, rainy and very wet conditions, but most importantly following just a little rain.

It shows how a new approach based on reducing the effective imperviousness of an urban catchment, using water sensitive urban design (WSUD) can lessen the damaging effect of urban stormwater. WSUD is a general name for a suite of measures now being used by stormwater managers and planners to intercept and treat urban water. WSUD can be applied at a range of scales, ranging from source to 'end-of-pipe'.

Bound copies are available from the CRC for Freshwater Ecology or an Adobe pdf file can be downloaded from www.catchment.crc.org.au/publications

NEW TOOLKIT SOFTWARE

CatchmentSIM

CatchmentSIM is a freely available stand-alone 3D-GIS application specifically tailored to hydrology based applications. It can be thought of as a collection of topographic and hydrologic analysis algorithms that have been purpose built for the process of hydrologic analysis and included in a Windows based user-friendly GIS environment.

CatchmentSIM is designed for use by anyone interested in automated catchment delineation and parameterisation from GIS data. However, the software is primarily focused on automated setup of run-files for flood and stormwater hydrograph models.

For further information visit www.toolkit.net.au/catchmentsim

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Alan Seed

Quantitative weather radar applications at the Bureau of Meteorology

Background

One of the aims in Project 5.05 (5A): "Hydrological modelling for weather forecasting" is to improve rainfall forecasts for lead times that are less than 6 hours. The most accurate method to forecast rainfall for the first couple of hours into the forecast period is to use a weather radar to estimate the spatial distribution of rainfall and then to advect this field forwards in time. At some point in the forecast period, sometime after 2 hours, the errors that are associated with this approach exceed those from a forecast based on numerical weather prediction (NWP). The Short Term Ensemble Prediction System (STEPS) is being developed by the Bureau, CRC for Catchment Hydrology, and the Met Office (UK) to combine the two forecasts (from radar and from NWP) into a single forecast out to a lead time of 6-12 hours, depending on the computer resources and the size of the domain covered by the weather radar network.

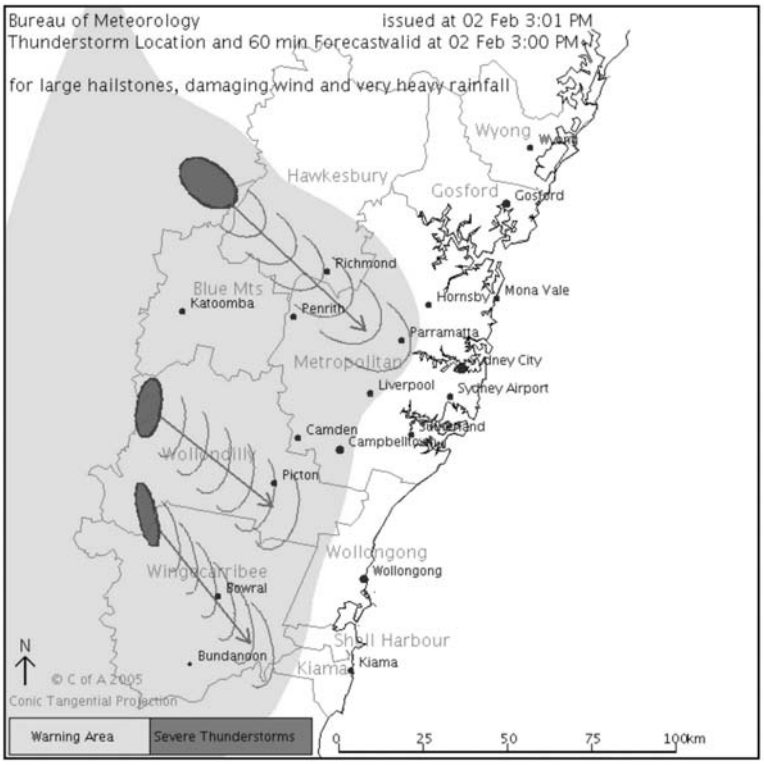

Figure 5.1. An example of a severe thunderstorm warning for the Sydney area published on the Bureau web site http://www.bom.gov.au/weather/nsw/

Weather radar

The first task for any short-term forecasting system is to convert the measurements of radar reflectivity into estimations of rainfall intensity. The CRC for Catchment Hydrology and the Bureau have been conducting research on the use of weather radar data for quantitative rainfall estimation for hydrological applications in particular. In parallel to this research, the Commonwealth Government allocated close to $62 million to allow the Bureau to modernise its radar network and supplement its Severe Weather Warning capabilities in key locations around the country. The Radar Network and Doppler Services Upgrade Project will replace 20 obsolete radars in the existing network of 65 radars and install new Doppler radars in Brisbane, Adelaide, Sydney, Tamworth, Melbourne, and Yarrawonga.

Decision support systems for weather warning

Improvements to the severe thunderstorm and flash flood warning services will be delivered through the a suite of applications that have been developed locally and abroad and have been packaged into a single decision support system by the Bureau. A special program of training for the operational forecasters will also be needed to utilise these advanced systems. The severe thunderstorm warning service identifies and tracks individual thunderstorms and predicts the location of these storms up to one hour ahead. Since time to prepare warnings is severely limited by the short lead-time for the warnings and the number of active storms within an area, the production of the warning in text and graphical form has been automated into the Thunderstorm Interactive Forecast System (Bally, 2004). Figure 5.1 shows an example of the graphical severe thunderstorm warning that will be published on the Bureau web site as the new radars start operational service.

Radar rainfall estimation – 'Rainfields'

In addition to the qualitative severe thunderstorm warning, a new service of providing quantitative radar rainfall estimations and forecasts will be provided for the areas that are covered by the new radars. The radar rainfall system is called Rainfields and was developed by the Bureau based on research undertaken by the first CRC for Catchment Hydrology and the Bureau.

Rainfields will be used to supply the rainfall data for the operational flood warning models where the catchments are under the radar, and will also supply the rainfall estimations and forecasts needed for the enhanced flash flood warning service. Images of quantitative rainfall since 9 AM, for the past 60 minutes, and current rainfall intensity are expected to be published on the Bureau web site as an enhanced service to the public. An example of the type of product that will be published is shown in Figure 5.2 for the Sydney area.

Evaluating 'Rainfields'

The Hydrology Unit of the Bureau is currently evaluating the use of Rainfields products in hydrological forecasting (Catchlove *et al*, 2005). Early results raise the possibility that the hydrological models will have to be recalibrated using the radar data. Interestingly, a case study on a catchment under the Melbourne radar also showed up the difficulty in detecting malfunctions in the real-time gauge network. Figure 5.3 shows the storm totals for the radar and gauge data where the apparent bias in the radar for the south-west of the catchment was due to the (undetected) failure of the closest gauge to this area. It is very difficult to detect gauge malfunctions in real-time as the gauge network is often sparse relative to the correlation length of rainfall at the accumulation interval being used. More case studies need to be undertaken once the new radars are installed and some significant storms sampled over a period of several years will be required before all of the current uncertainties can be resolved.

Rainfall forecasts using 'Rainfields'

Rainfields is also used to serve rainfall forecasts to clients. The deterministic nowcasting component in STEPS is used to generate rainfall forecasts for lead times up to 90 minutes ahead, which are updated at 5-minute intervals as new radar data become available. These are expected to be published as forecasts of 30, 60, and 90-minute rainfall accumulations on the Bureau website and used as part of the flash flood warning service.

Maps based on 'Rainfields'

It is planned to extend the Rainfields products to include maps derived from interpolating between rain gauges, and combined gauge and radar maps using a method based on Sinclair and Pegram, 2004. The advantage of this technique is that it can make optimum use of a dense rain gauge network and the radar as a single system and adds the small-scale variability seen by the radar to the smooth but unbiased field derived from the rain gauges. Figure 5.4 shows an example of a merged radar and rain gauge map based on 15-minute rainfall accumulations from the Kurnell radar and the Sydney Water rain gauge network.

Significant investment in research and radar technology has enabled the Bureau to move towards a more quantitative use of the radar network. This move towards quantitative applications increases the value of the radar network to the Australian public by improving existing services and making new services possible.

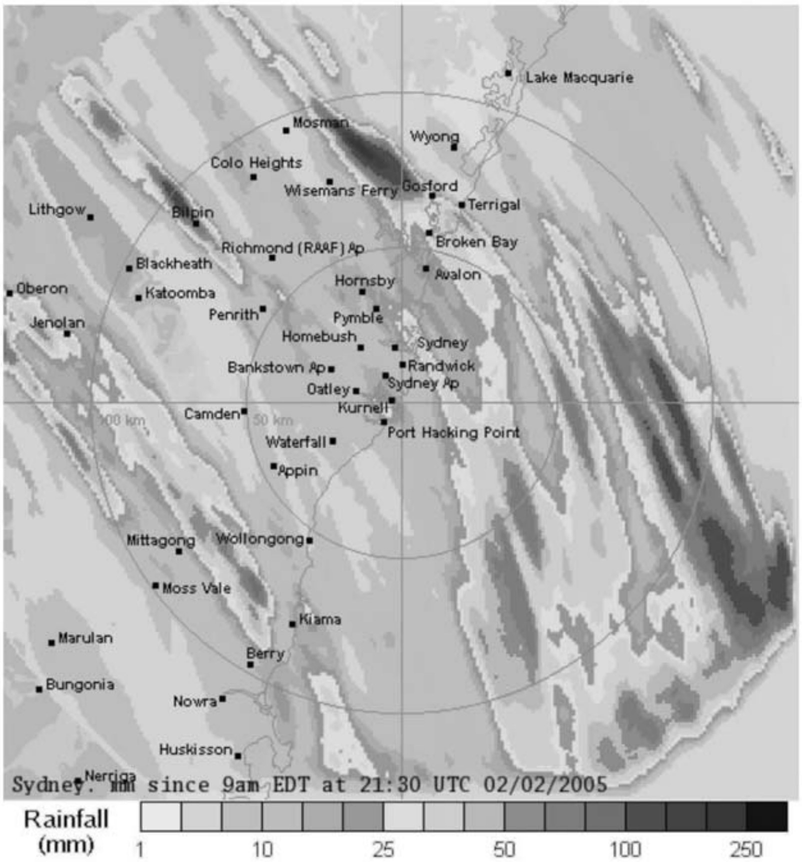

Figure 5.2. "Since 9AM" rainfall accumulations for Sydney on 2 February 2005, the same day as the severe weather warnings shown in Figure5.1.

NEW TECHNICAL REPORT

Stochastic Generation of Point Rainfall Data at Subdaily Timescales: A Comparison of DRIP and NSRP

By

Andrew Frost
Ratnasingham Srikanthan
Paul Cowpertwait

Technical Report 04/9

One of the goals of the Climate Variability Program in the Cooperative Research Centre (CRC) for Catchment Hydrology is to develop and test computer programs for generating stochastic climate data at timescales from less than one hour to one year and for point sites to large catchments. The appropriate models will be part of SCL (Stochastic Climate Library - a suite of stochastic climate data generation models), a product in the CRC's Modelling Toolkit (see www.toolkit.net.au/scl).

This report describes the evaluation of two point subdaily stochastic rainfall models - the Newman-Scott Rectangular Pulse (NSRP) and the Disaggregated Rectangular Intensity Pulse (DRIP). The models are evaluated using relatively long pluviograph data from ten major Australian cities and regional centres.

Bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au/publications

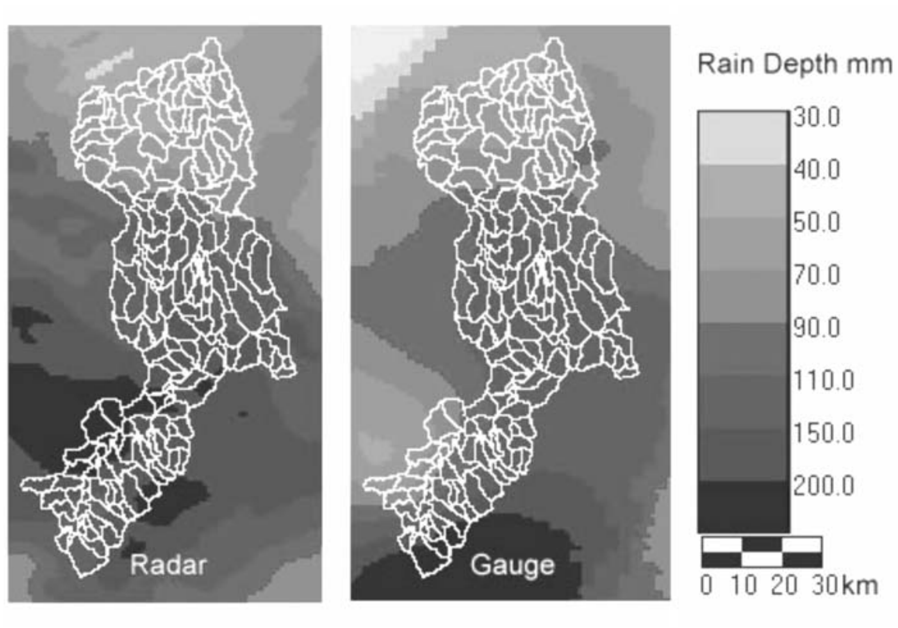

Figure 5.3. Storm total rainfall based on radar and rain gauge measurements, for the Barwon catchment near Melbourne.

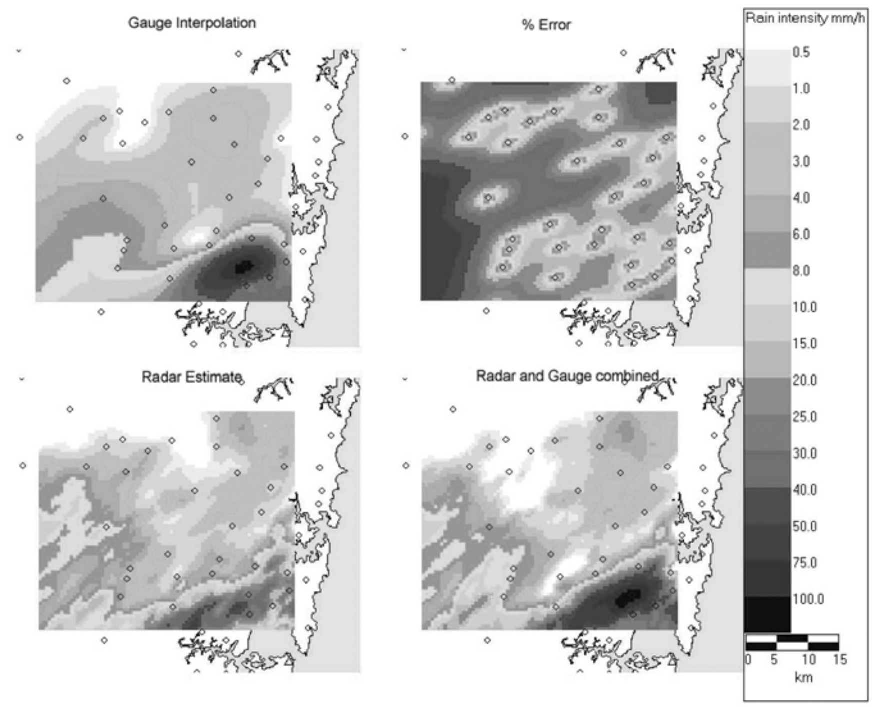

Figure 5.4. Proposed merging radar and rain gauge data. The gauge interpolation is based on a Kriging interpolation method and the errors in this analysis are shown as a percentage of the field variance. The radar estimate includes adjusting the mean towards the mean of the gauge network; the combined field adds the small-scale detail of the radar to the smooth gauge field.

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PROGRAM 6

RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Mike Stewardson, Dave Wilson and Brian Finlayson

Evaluating Channel Migration Rates from Historical River Maps.

Background

River planform is the outcome of flow regime, valley slope, sediment size and supply, and bank stability. With the exception of valley slope, these variables have been affected by European colonisation in Australia.

Commencing with settlement, floodplain rivers have responded to a sequence of disturbances usually including riparian and catchment clearing, floodplain drainage, construction of artificial levees, removal of snags, erosion control and flow regulation.

Now we are commencing widespread river restoration activities (mostly riparian restoration and environmental flows) intended to reverse some of these disturbances. So we need to ask what our rivers would look like now without the effects of European farming practice. It's not so easy to answer this question with very few undisturbed lowland rivers remaining as points of reference.

About the Study

Periodic mapping programs allow us to examine changes in river alignment over the past 150 years. Major Victorian rivers were first surveyed shortly after the arrival of Europeans; typically between 1850 and 1900 and are recorded in the earliest version of Parish Plans. These maps offer a snapshot of the rivers prior to, or during the initial stages of regulation, abstraction, land clearing and the major periods of "river improvement". Major surveying work was again carried out by the Victorian river engineer HG Strom in the 1930s. Plans representing recent conditions are available from digital versions of the 1:25,000 topographic maps.

Recent work led by Dave Wilson (SAGES, The University of Melbourne), has used GIS software to geo-reference these three map sets spread across the period of European settlement (1860s, 1930s, 1980s) to a common coordinate system, according to Victorian cadastral information (examples are shown in Figure 6.1). Map sheets corresponding to the 1860s and 1930s are digitally aligned with current electronic maps so that the old river courses may be overlaid on the modern course. For each map set, the left and right banks and other features of the channel are digitised manually.

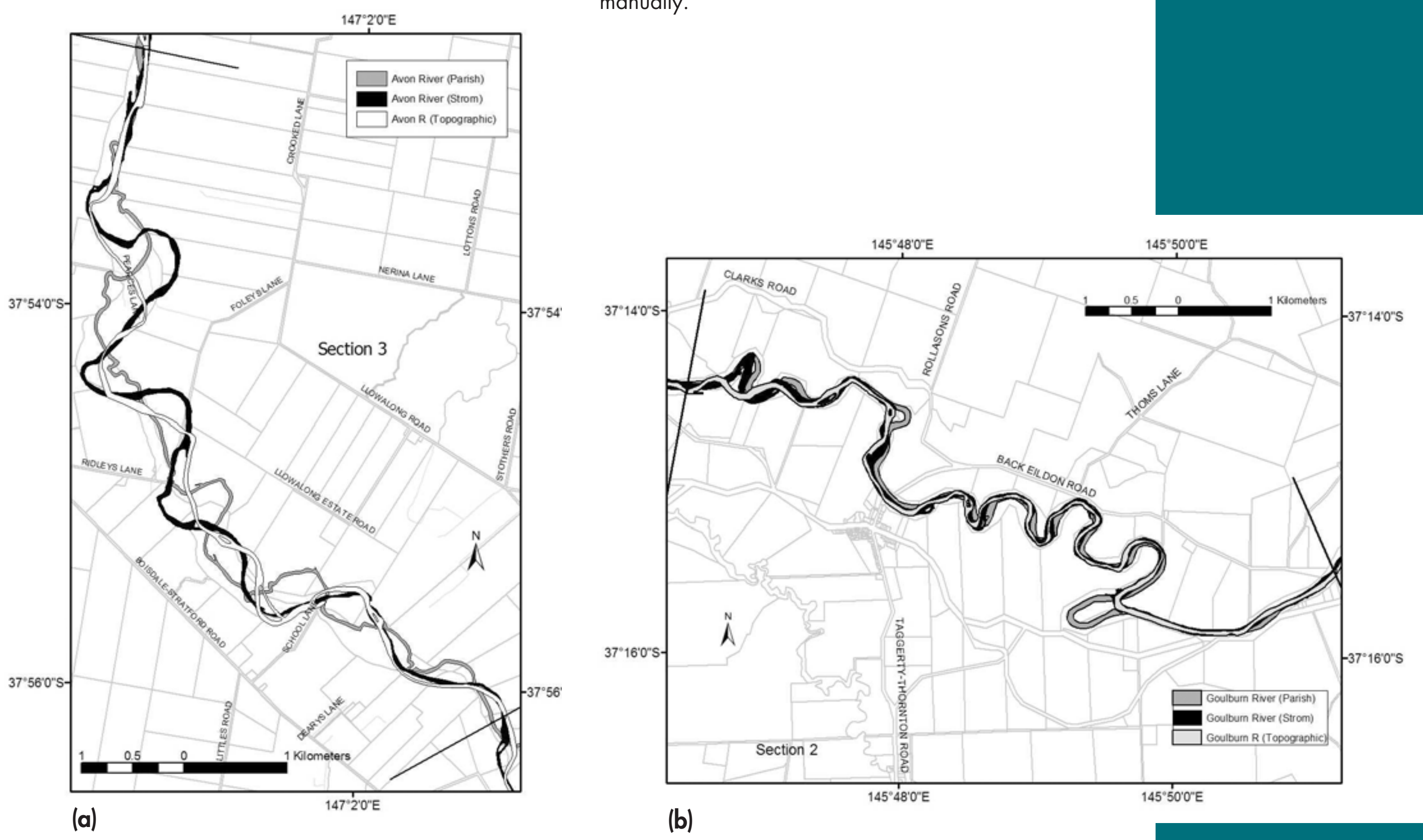

Figure 6.1: Historical river plans geo-referenced using Cadastre. Examples are for sections of (a) Avon River and (b) Goulburn River

8TH INTERNATIONAL RIVER SYMPOSIUM 2005

Water and Food Security – Rivers in a Global Context
6-9 September 2005, Brisbane

2005 Thiess Riverprize – Call for Nominations

Detailed information can be found at www.riverfestival.com.au /symposium

NEW TECHNICAL REPORT

Evaluating the Effectiveness of Habitat Reconstruction in Rivers

By
Michael Stewardson
Peter Cottingham
Ian Rutherfurd
Sabine Schreiber

Technical Report 04/11

River restoration is a new science and many projects are necessarily experimental. Our understanding of processes of degradation is improving but our ability to prescribe efficient restoration treatments which might include environmental flows, reintroduction of large wood debris and riparian restoration is still limited.

This report reviews approaches to river restoration. Those considering an evaluation will benefit from reading the limitations and advantages of the various approaches. River engineers, aquatic ecologists and fluvial geomorphologists now work in multi-disciplinary teams to plan river restoration work including monitoring and evaluation. In recognition of this, two chapters of this report are devoted to discussing conceptual aspects of restoration planning and evaluation as common ground across the disciplines.

Bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au/ publications

An automated GIS process was used to measure rates of channel change during the two time periods defined by the map dates. The historical map sequence show the extent of channel movement since settlement. Channel movement can take the form of migration through bank erosion (normally at channel bends) or changes in channel alignment as a result of bend cut-off or channel avulsion. Distinguishing those sections of our rivers which have migrated through (i) bank erosion or (ii) cut-off and avulsion, was the most difficult part of this project and had to be carried out manually.

Significance to Catchment Management

Channel movement is the result of erosion and deposition of sediments which contribute to the catchment sediment budget. Bank erosion rate is a particularly important parameter in SEDNET (the catchment sediment balance model available from the Catchment Modelling Toolkit website). Bank erosion rates can be estimated in the field using a variety of techniques, but generally focussing on individual bends or cross-sections. Using historical map sequences, we are able to estimate bank erosion rates along substantial lengths of river (10's of km). Bank erosion estimates averaged over longer reaches are more relevant for catchment-scale sediment budgets than the more widely available point estimates.

Sections of the river channel which are abandoned by cut-offs and avulsions become floodplain wetlands which gradually infill with sediments over long periods (decades or longer). So channel movement is important for maintaining the variability of wetland types in our floodplain landscapes. Most geomorphic monitoring and restoration occur at the reach-scale and is relatively short-term relative to the processes of wetland formation. We currently don't have much idea of the long-term and on-going changes in changes in floodplain morphology and wetland distribution. This project provides data on the rate of cut-ff and avulsions over two periods of European settlement which can be compared to the number of wetlands found along the floodplain.

There are well-documented cases of rivers widening soon after European settlement, such as the lower Snowy River in East Victoria. Channel widening has a significant hydraulic effect similar to reducing river flow (i.e. increasing shallower and slow-flowing areas at the expense of deeper-faster flowing water). If widespread, channel widening may have had an impact on stream habitats in lowland rivers, similar in magnitude to the effect of flow regulation. Historical sequences of river plans indicate changes in channel width, although the accuracy of this information depends on consistency in the methods used to define the channel edge on the plans.

Results to Date

Results to date indicate remarkable consistency in the rates of erosion across the rivers and between the two periods (settlement to 1930s and 1930s to present). Rates of erosion are typically in the range 0.3 to 0.6 m/year. That's an average rate per unit length of channel, so some sections, particularly on bends, will be eroding more quickly than this. Our results also show that up to 40% of the channel can migrate through cut-off or avulsion over the periods considered. This suggests that sediment budget modelling may need to represent erosion associated with these sections separately from sections migrating through bank erosion.

We are preparing a Technical Report on this work including maps showing the three historical river courses for all the rivers we have included in the study. This report will also give statistics on rates of channel movement and other measurements taken from the river plans. The next step is to relate these channel changes to catchment and riparian management. This is going to require some historical research to determine the timing of catchment disturbances relative to the drawing of maps. We hope to continue this work over the coming year, but this is subject to availability of funding.

Only a few larger river restoration and research projects include broader-scale assessment of historic geomorphic changes. There is little understanding of the geomorphic changes in lowland rivers since settlement, particularly changes in the distribution of floodplain wetlands. We consider this work will be an important contribution to understanding historic geomorphic adjustments in rivers in Australia and the longer-term effects of land and river management decisions.

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COMMUNICATION & ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect – March 2005

At a glance – a summary of this article

The CRC for Catchment Hydrology has scheduled a Catchment Modelling School in both Brisbane (30 June – 8 July 2005) and Sydney (14-22 July 2005). The Catchment Modelling School represents the climax of the CRC and will offer over 30 workshops in all areas of catchment modelling. Registrations of interest are now being accepted at www.toolkit.net.au/school

Catchment Modelling School

The CRC for Catchment Hydrology ran the first Catchment Modelling School in Melbourne during February 2004. The event was very successful with over 300 participants attending one or more of the 32 workshops offered during the two week period. A subsequent analysis of feedback forms showed that over 90% of participants would recommend their particular workshop to colleagues. The formal and informal feedback we received was very encouraging and consequently as a 'grand finale' to the CRC we have scheduled two more Catchment Modelling Schools, one each in Brisbane and Sydney.

School details

The Brisbane School is planned for 30 June – 8 July 2005. This School will be held at the Nathan campus of Griffith University in Brisbane. The second School will be held at the Darlington campus of The University of Sydney during 14 – 22 July 2005. Although the CRC will officially finish on the first day of the School in Brisbane, these dates were chosen to utilise the University facilities during the mid year semester break.

EOI and registration dates

Expressions of interest (EOI) are now being sought through the Catchment Modelling School website at www.toolkit.net.au/school. In order to develop a schedule of workshops, we are asking potential participants to register their interest before 7 April 2005 in particular workshops that they would like to attend. As an incentive, those people who express interest will be given the opportunity to register first for their chosen workshops. General registrations will be accepted for the final range of School workshops from Monday 18 April 2005 with a closing date of Tuesday 31 May 2005.

Aspects of the individual workshops

The School is modular in format and includes seminars and workshops by many of Australia's leading catchment modellers. The thrust of the School is a series of hands-on workshops where participants are trained in the use of various hydrologic and related models.

The fee for Catchment Modelling School Workshops will be $440 per day per participant with reduced rates for employees of CRC Parties, Associates, Research and Industry Affiliates and full time postgraduate students. The workshop fee per day includes morning and afternoon teas, lunch and the use of a computer for each participant. All workshops include a 'take home' package of relevant documentation for each participant and access to the Catchment Modelling Toolkit software - individual workshop information contains further detail.

Target audience

The School is designed for natural resource management sector professionals to choose specific workshops to improve their hydrologic and related modelling skills. The School targets all professionals in the hydrologic modelling community as well as a range of model users and those commissioning modelling studies, specifically:

- Technical staff from natural resource management agencies
- Natural resource management policy makers
- Consultants
- Full-time Postgraduate students

Workshops to be offered

Overleaf is a list of workshops that could be offered at each of the Brisbane and Sydney Schools (note that some workshops appear under more than one category). We hope that many *Catchword* readers take the opportunity to register their interest in one or more of these courses to assist us with our planning. I look forward to seeing many of you in July 2005 at what will be the 'last big bash' of the CRC for Catchment Hydrology.

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Communication and Adoption Program
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CATCHMENT MODELLING SCHOOL 2005

BRISBANE
30 June - 8 July 2005
at Griffith University

SYDNEY
14 - 22 July 2005
at the University of Sydney

Following the success of the Catchment Modelling School held in Melbourne last year, the CRC for Catchment Hydrology is planning similar events in both Brisbane and Sydney during July 2005.

We are now calling for participants to register their interest in specific workshops to assist us in developing a schedule from over 30 possible courses.

As an incentive, people who express interest before 7 April 2005 will be given the opportunity to ensure their workshop place in advance of a general call.

You can obtain further information and register your interest now by visiting http://www.toolkit.net.au/school

Proposed workshops at the 2005 Catchment Modelling Schools in Brisbane and Sydney.

For further information and to register your interest in any of these workshops please visit www.toolkit.net.au/school

Understanding Catchment Modelling

- An Introduction to Catchment Modelling
- Advanced Catchment Modelling - techniques for modellers

Modelling Frameworks

- CatchMODS and ICMS
- Model Development Using The Invisible Modelling Environment (TIME)
- Advanced Model Development Using The Invisible Modelling Environment (TIME)
- Modelling Recharge and Water Balance in the unsaturated zone using CLASS Unsaturated Moisture Movement Model.
- Modelling Pasture and Crop Growth Dynamics, Recharge and Water Balance in the unsaturated zone using the CLASS Pasture and Crop Growth Models.
- Whole-of-catchment Modelling using E2
- Advanced Whole of Catchment Modelling using E2
- CatchmentSIM: Terrain Analysis and Hydrologic Assessment

Climate Variability and Data Analysis Tools

- Stochastic climate data generation (SCL)
- Seasonal hydroclimate forecasting and the NSFM software
- Detecting trends in environmental time series data
- CatchmentSIM: Terrain Analysis and Hydrologic Assessment

Environmental Flows

- Using the Hydraulic Analysis Module of the River Analysis Package (RAP)
- Using the Rules Based Module of the River Analysis Package (RAP)
- Using the Time Series Analysis Module of the River Analysis Package (RAP)

Rainfall-runoff Modelling

- Utilising the IHACRES rainfall-runoff model
- Rainfall Runoff Library (RRL) and Forest Cover Flow Change tool (FCFC)

Salinity

- Land-use impacts on dryland salinity

River Engineering

- CHUTE and RIPRAP – Hydraulic Design of Rock Protection for the Stabilisation of stream beds and banks
- Basic flow profile modelling using HEC-RAS
- Advanced flow profile modelling using HEC-RAS
- Stream Crossing Design using Minimum Energy Loss Structures (MELS)

Urban Hydrology

- MUSIC Version 3 Training (three days)
- MUSIC Version 3 update training (one day)
- Aquacycle – a Daily Urban Water Balance Model

River System and Water Allocation Modelling

- Modelling river basins using IQQM (Integrated Quantity and Quality Model)
- Modelling river basin management using IQQM (Integrated Quantity and Quality Model)
- Water ReAllocation Model (WRAM)

Water Quality Modelling

- SedNet – Sediment and Nutrient Budgets for River Networks
- Utilising the Land-use Option Simulator software (LUOS)
- Whole-of-catchment Modelling using E2
- Advanced Whole-of-Catchment Modelling using E2
- The Riparian Nitrogen Model (RNM) - A Tool for Targeted Riparian Restoration in Catchments
- Land-use impacts on dryland salinity
- CatchMODS and ICMS
- MUSIC Version 3 Training (three days)
- MUSIC Version 3 update training (one day)

Water Trading

- Water ReAllocation Model (WRAM)

Register at www.toolkit.net.au/school

POSTGRADUATES AND THEIR PROJECTS

Yong Li

When you see my name, you will probably think that I am from China. Yes, I was born and raised in China. When you recognise my Chinese name, you may think that I am male. No. My first name in Chinese is normally for a boy. Even I still wonder why my father gave me a boy's name even though I have an elder brother. After I grew up, I was thinking to change my name, but I decided to keep it. I told myself that a girl can do the same job as a boy.

I completed my four-year university study following the competitive nation-wide entrance exams and obtained a Bachelor of Engineering in 1989 in China. I was trained to become a water engineer. The courses provided there are multi-disciplinary and engineering orientated. My understanding and interest in water engineering started to build up when I undertook a 13-week graduation project about sewage collection and treatment system design for a middle-sized city.

After graduating, I got a position at a university in southern China as an associate lecturer of Water Engineering, in its Department of Civil Engineering. Afterwards, I was sent to TongJi University, Shanghai, for one year, to be trained as a university teacher in Water Engineering. Five years later, I was promoted as a lecturer and worked at the same university until I left China in 1998. In my eight-year teaching period, I truly enjoyed the challenges along with my students. I taught some courses including Water Supply and Wastewater Drainage for Buildings, and Water Treatment Microbiology. At the same time, I designed water supply and drainage systems for buildings including high-rise buildings.

I came to Australia with my family seven years ago. I spent a few years adjusting myself to the new environment. Now I'm doing my second-year postgraduate studies at Monash University in association with the CRC for Catchment Hydrology. My supervisors are Drs Ana Deletic and Tim Fletcher. I'm working on developing physically-based methods in modelling the performance of a series of urban stormwater treatment systems in removing sediment.

Urban growth and redevelopment has led to significant changes in urban stormwater quantity and quality. The degradation of receiving water quality is affected by surface stormwater treatment systems such as stormwater ponds, wetlands, buffer strips and grassed swales etc. They can remove pollutants ranging from gross solids to very fine particulates, even part of the dissolved particles, through some physical sedimentation processes. Modelling sediment trapping efficiency is an important aspect for the design and evaluation of constructed facilities, because a range of key pollutants including phosphorus and metals are largely transported in particulate forms.

The aim of my research work is to develop a physically-based model for long-term and event-based prediction of the behaviour of TSS and associated (or attached) pollutants in a series of surface-flow stormwater treatment systems such as open-water ponds, vegetated wetlands and grassed swales. The fundamental sedimentation processes, including deposition and re-suspension, will be explicitly considered as two major mechanisms for sediment removal. The modelling method will aim to strike a balance between ease of use and the complexity of the system considered. Hopefully, the model can be applied across a number of surface-flow treatment systems. The results obtained in the laboratory experiments will be used to refine the formulation of the model, which will then be validated by analysis of field data.

Like all other postgraduate studies, my research objective is a challenging topic. I have to pay particular attention to past studies on how to establish and verify a model based on what actually happens to sediments. Initial results have already identified the variation of model parameters for different sorts of treatment systems. It is expected that a better relationship between these model parameters and physical features will be obtained.

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NEW TOOLKIT PRODUCTS

Over the last couple of weeks a number of new Catchment Modelling Toolkit products have been released including:

CLASS - a physically based distributed eco-hydrological modelling framework that can be used to predict land-use effects at paddock, hillslope and catchment scales.
www.toolkit.net.au/class

MELS - a hydraulic design and analysis suite that enables designers to quickly trial several alternative Minimum Energy Loss (MEL) culvert designs, checking for basic structure dimensions, performance under adverse conditions such as high or low flow and sedimentation issues.
www.toolkit.net.au/mels

RIRAP - a spreadsheet program for the design of rock lining (rip-rap) for bank protection.
www.toolkit.net.au/riprap

For further information visit www.toolkit.net.au

CRC PROFILE

Our CRC Profile for March is:

Christine Forster

Christine Forster has been an independent member of the CRC for Catchment Hydrology Board since 2001. In her role, Christine has brought to our Board her extensive experience and insight into land and water management in Australia.

Following graduation with a BSc degree from The University of Melbourne in 1959, her first job was as an experimental officer at the CSIRO Animal Health Laboratories.

In 1966 Christine took up a position as bacteriologist chemist in Darwin with the Water Resource Branch of the Northern Territory Administration and was responsible for monitoring the quality and treatment of domestic water supplies throughout the territory; and monitoring for specific purposes such as export abattoirs, stock use and irrigation. Christine was also involved in preparatory studies for the development of uranium mining in the Northern Territory.

Christine moved to Canberra in 1971 to join the Secretariat of the Australian Water Resources Council (AWRC) and worked on the development of a national water quality monitoring assessment program.

From 1974-76 she was Assistant Secretary of the resources Management Branch of the Water and Soils Division of the Commonwealth Department of Environment and Conservation.

In 1976-77 she acted as first Director of the Australian Heritage Commission, which developed the Register of the National Estate.

In 1977, Christine and her family moved back to Victoria to Castlemaine, where she was actively involved in community affairs and was elected to the Castlemaine City Council.

In 1982, she returned to the family farm at Ararat and became involved with a ram breeding program, soil and water conservation and a long-term tree propagation and planting program. Some 150,000 trees have been planted on the farm over 23 years.

From 1984 to 1990 Christine was Chairperson of the Board of Management of the Rural Water Commission of Victoria and for five years from 1988 was Chairperson of the Board of Directors of the National Irrigation Research Fund.

Christine was a member of many boards, committees and councils involved with managing Victoria's and Australia's water and natural resources throughout the 1990s.

Currently, she is Chairperson of the Victorian Catchment Management Council, the peak advisory body to the State Government on catchment management. She is a member of the Victorian Water Trust Advisory Council and a director of VicSuper Pty Ltd.

Christine was awarded a Centenary Medal in 2003 for services to conservation and our environment.

Christine Forster
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WHERE ARE THEY NOW?

Report by Teri Etchells

How quickly we move on. Before submitting my PhD I found it hard to imagine what life would be like afterwards. I think I envisaged a simple life without pressure or deadlines. Now I find it hard to remember what life was like then, but I'm pretty sure my 'to-do' list wasn't as long as it is now.

I submitted my thesis about one year ago and was very happy to be appointed as a Research Fellow in the Department of Civil and Environmental Engineering at The University of Melbourne. Three months later I had my first baby, a beautiful girl named Cassandra. Three months after that I returned to work part-time, resumed my research and began lecturing (third-year engineering students) for the first time. Needless to say, it has been a busy year!

My doctoral research focussed on the problem of developing efficient, sustainable water markets in the face of uncertainty and market failures and was titled 'A methodology to calculate water trading exchange rates in the Murray-Darling Basin'. This project formed part of the Sustainable Water Allocation Program in the CRC for Catchment Hydrology. My research approach drew upon techniques from hydrology, statistics and economics to create an applied, multi-disciplinary solution. I believe that undertaking my PhD was extremely beneficial in improving my ability to think analytically, and dramatically expanding my awareness of scientific concepts.

As a research fellow I have been focussing on issues associated with quantifying and managing uncertainties associated with the measurement and modelling of water resources, in particular, those which have major implications for water allocation and management. Water allocation is a pressing issue as water scarcity increases in Australia and around the world. However, there are frequently large hydrologic and information uncertainties preventing optimal water management and policy development. There is a need for improved methods based on multi-disciplinary approaches and I hope I can help develop those approaches. I am pleased that the eWater CRC will be addressing many of these needs and look forward to being involved.

In the Department I am continuing involvement with many CRC for Catchment Hydrology folks, in particular working with Professor Tom McMahon and Associate Professor Hector Malano. Also, I have been working with Professor John Langford as he establishes the Melbourne Water Research Centre, a very exciting incubator for 'needs-based' water research at The University of Melbourne.

I would like to take this opportunity to thank my supervisors (Tom McMahon, Hector Malano and Barry James from the Victorian Department of Sustainability and Environment), as well as everyone involved in the CRC for Catchment Hydrology. I feel very lucky to have been a postgraduate student in the CRC for Catchment Hydrology and look forward to more contact with many of you in the coming years through eWater.

Teri Etchells
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UPCOMING CONFERENCE

Barmah Forest: Indigenous Heritage, Ecological Challenge
18-19 June 2005.
The Royal Society of Victoria

The Barmah-Millewa Forest is an area of great ecological significance and interest. For decades it has been the focus of much archaeological, historical and scientific research. The Victorian Environmental Assessment Council is about to begin its Riverine Red Gum Forests Investigation, after which decisions will be made as to the future of these forests. The conference is a response to the great degree of interest in this remarkable area.

For further information contact tony.ladson@eng.monash.edu.au or download an invitation from www.personal.monash.edu.au/~ladson/BarmahInvite5.pdf

COOPERATIVE RESEARCH CENTRE FOR

CATCHMENT HYDROLOGY

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PP338685/00026

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OUR MISSION

To deliver to resource managers the capability to assess the hydrologic impact of land-use and water-management decisions at whole-of-catchment scale.

OUR RESEARCH

To achieve our mission the CRC has six multi-disciplinary research programs:

- Predicting catchment behaviour
- Land-use impacts on rivers
- Sustainable water allocation
- Urban stormwater quality
- Climate variability
- River restoration

CRC AUSTRALIA

The Cooperative Research Centre for Catchment Hydrology is a cooperative venture formed under the Commonwealth CRC Program between:

Brisbane City Council
Bureau of Meteorology
CSIRO Land and Water
Department of Infrastructure, Planning and Natural Resources
Department of Sustainability and Environment, Vic
Goulburn-Murray Water
Grampians Wimmera Mallee Water Authority
Griffith University
Melbourne Water
Monash University
Murray-Darling Basin Commission
Natural Resources and Mines, Qld
Southern Rural Water
The University of Melbourne

Associates:
Water Corporation of Western Australia

Research Affiliates:
Australian National University
National Institute of Water and Atmospheric Research, New Zealand
Sustainable Water Resources Research Centre, Republic of Korea
University of New South Wales

Industry Affiliates:
Earth Tech
Ecological Engineering
Sinclair Knight Merz
WBM

www.catchment.crc.org.au