NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

# CATCHWORD

NO 129 JULY 2004

## A NOTE FROM THE DIRECTOR

**Rodger Grayson**

**Inside...**



COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

## THE EWATER CRC – ENTERPRISE, ENVIRONMENT, EDUCATION

Improved management of water to support a vibrant economy and a quality environment is front and center on the national stage. The National Water Initiative is taking shape and States are developing detailed plans for smarter water use such as Victoria's "Our water our future" released recently. Against this background, new criteria for CRC bids were announced late last year that place a strong emphasis on economic and commercial benefits, moving away from "public good" as a primary justification for CRCs. The eWater CRC has been developed to meet these challenges. It is both evolutionary and revolutionary. Evolutionary in the way it builds on the solid foundations of two highly successful CRCs and revolutionary by addressing, with a strong commercial focus, the complete water cycle management across urban and rural catchments.

As Rob Vertessy mentioned in the March 2004 issue of *Catchword*, the eWater CRC bid is being developed by the Interim Partners Committee, chaired by Don Blackmore, with Gary Jones as interim CEO. Gary has worked tirelessly over the last few months to bring together an unprecedented partner alliance of private sector water retailers, public sector water & environment managers, urban & catchment management authorities, and major R&D providers across eastern & southern Australia. The Stage 2 Business Case was submitted on 2 July, one of thirty-three that were invited to submit Stage 2 cases following initial submissions in March this year. Final announcements of successful bids are expected in late November or December this year.

The eWater CRC's mission is to:

- produce a high value, market-focussed product portfolio that is founded on world's best practice in collaborative environmental, engineering and socio-economic water research;
- establish public and private sector partnerships that strengthen the placement of eWater goods and services in target national and international markets;
- seek new partnerships with small to medium sized enterprises that lead to product innovation and commercial success;
- establish an external revenue stream to fund the long-term development and after-sales service of eWater products;
- support industry partners and researchers to jointly apply eWater products in real-world management situations; and
- build broad customer and public trust in eWater goods and services through professional marketing and strong corporate citizenship.

Central to the eWater CRC is a portfolio of "products" - practical tools for use by land and water managers and those in water dependent industries. These are designed to increase operational efficiency for water and catchment authorities, river and groundwater managers, and allow governments, corporations and private companies to deliver water quantity, quality and environmental outcomes at reduced costs. These "products" are the logical extension of our catchment modelling toolkit and other knowledge outputs, but are much more ambitious and far reaching in scope. The general needs of these products were identified by industry partners earlier in the year and have been developed through workshops with researchers into "product plans". There are five initial core products proposed, built around the broad notion of "toolkits", including not only software, but also integrated data bases, guidelines etc:

A. River operations and management

B. Urban water systems

C. Water and pollutant accounting

D. River restoration and environmental infrastructure

E. Integrated monitoring and assessment systems

Nine research programs have been developed to deliver the core models and knowledge outputs to assemble the products, analyse emerging areas of risk for successful use of these products in the future, and develop the intellectual capital and innovation needed to respond to new opportunities. The new challenges for the eWater CRC mean new research partners, bringing their skills in risk, uncertainty, multi-criteria optimisation, socio-economic analysis and groundwater/surface water interactions. These skills add to the formidable capacity across the existing CRCs.

The nine research programs are:

1. Systems integration and prediction
2. Software development and product design

## CRC PUBLICATIONS LIST

**An updated list of CRC publication is included with this issue of *Catchword.* Additional printed copies are available from the Centre Office.**

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

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3. Risk, uncertainty and optimisation
4. Urban design and processes
5. Socio-economic evaluation
6. Biological response to physical and chemical drivers and management
7. Monitoring systems and technologies
8. Impact of climate variability and extreme events
9. Hydrological and ecological connectivity

Programs 1 and 2 will provide over-arching guidance for integration and development across the research and product portfolios. The product development team leaders will also play a key role in research planning and integration (see Figure 1). Program 1 focuses on the conceptual aspects of integration while Program 2 will ensure integration and compatibility of the modelling technology. Programs 3 to 7 focus on providing the knowledge components and outputs required for product development and the underpinning science for Programs 1 and 2. Programs 3 and 7 are "cross-cutting" in that there will be components of all Programs related to risk, uncertainty, optimisation and socio-economic evaluation. Programs 8 and 9 are foundation research programs which will elucidate and quantify emerging risks for the successful application and utility of products. They will also maintain and build our underlying intellectual capital, and interact with and inform all other programs.

As with our current CRC, the research programs and projects will be developed to directly underpin product development. It is expected that researchers will work across several programs, encouraging the multidisciplinary approaches and integrative thinking that will be vital to meeting industry needs. We have developed a detailed planning matrix linking product component requirements to research program outputs.

This is a model that has been road-tested in our CRC, where an "integration blueprint" guides the structure and compatibility of all programs and projects. The same approach to integration will be adopted by the eWater CRC.

Figure 1 shows the broad structure of the eWater CRC. Commercialisation and adoption of eWater products are the key outputs. The product portfolio is developed by industry-led teams including key researchers. An "integration blueprint" approach is used to direct the appropriate research to underpin the products.

The eWater CRC is an exciting prospect and should be ideally placed to play a major role in supporting the Australia-wide push for smart use and management of our finite water resources. We will face strong competition for Commonwealth funding with fewer than fifty percent of the Stage 2 submissions expected to be funded. Still I believe our Stage 2 Business Case is extremely strong and involves an outstanding group of committed industry and research partners. It is built on a foundation of two CRCs with enviable track records in delivering practical outcomes for industry.

Congratulations to Gary Jones, his team, and the Interim Partners Committee for the huge effort over the last couple of months. Thanks also to our Program Leaders, David Perry and John Molloy for their input to the product plans and Business Case. We have the capacity to deliver major economic and environmental benefits to Australia at a time when water issues are high on the national agenda. Let us hope that the Commonwealth agree!

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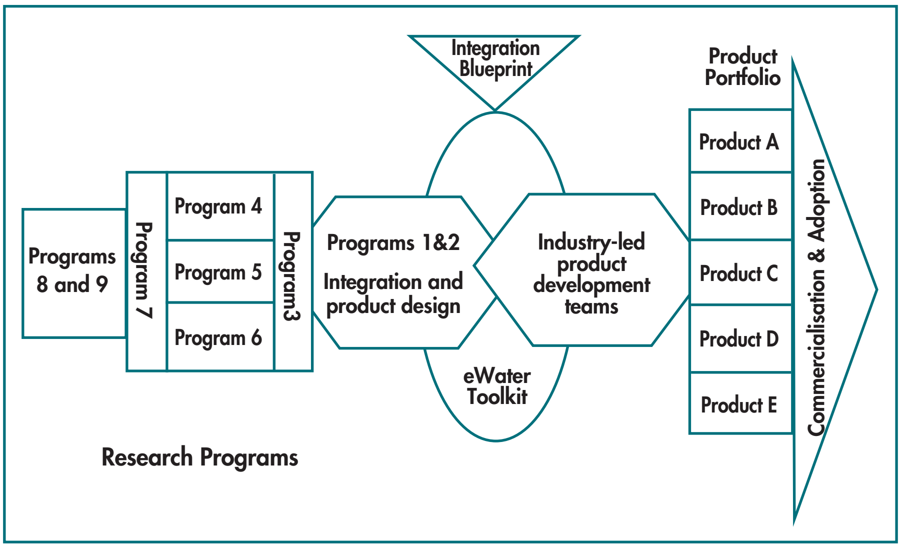


*Figure 1*

PROGRAM 1

# PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

## Report by Geoff Podger

### Induction of Toolkit products

*Introduction*

We are quite a long way down the track in terms of our software development. There are currently seven products available on the Catchment Modelling Toolkit website (www.toolkit.net.au):

- Chute (Rock chute design)
- Music (Design of urban stormwater management systems)
- RAP (River assessment, environmental flow planning and rehabilitation)
- RRL (Library of rainfall-runoff models)
- SCL (Library of point stochastic climate data generators)
- SedNet (Sediment budget generation)
- TIME (Framework for creating, testing and delivering models)

There are many more products that will be coming out over the next year. There are three products that will be released very soon:

- Soil hydraulic properties for Australia: This is a data product (set) of soil hydraulic properties across Australia available in both Geographic (on GDA94) and Map Grid of Australia coordinate systems. The spatial resolution is 0.01 degrees or 1km.
- LUOS: The LandUse Options Simulator (LUOS) is designed to help rank land use change options on the basis of the environmental services provided by the land-use change.
- TREND: Designed to facilitate statistical testing for trend, change and randomness in hydrological and other time series data. TREND incorporates twelve statistical tests.

This article discusses the processes that are involved in getting products ready to be released on the website. For users of our software, it all appears reasonably simple and that is exactly how we want it to be. All you need to do is to go to the Toolkit site, select the product, download and install. If you already have a TIME based product and are connected to the web it will notify you when to update. Behind the scenes a whole lot of things need to happen to make this all work seamlessly. Most of this responsibility and hard work resides with Product Managers.

*Role of a Toolkit Product Manager*

Each product in The CRC's Catchment Modelling Toolkit is assigned a Product Manager. The Product manager is responsible for:

- Coordinating the induction of the product into the Toolkit.
- Managing the Intellectual Property (IP) arrangements.
- Defining any special licence conditions.
- Managing the maintenance of the product. This includes bugs, feedback and response to e-groups.
- Coordinating training.
- Supporting communication and adoption of the product.

There are currently 21 Product Managers that are working hard to deliver and maintain products on our website. They are doing an extraordinary job of coordinating the release of products and ensuring that the products are robust and quality assured. Much of the thanks for the products should go to these people.

*Creating a new product*

Each product in the Catchment Modelling Toolkit must go through a defined induction process. This is essential to ensure that the product is appropriate for the site, it has had sufficient testing, is well documented and training material is provided.

There many steps that are involved in creating a product, from when a Product Manager first talks to the Toolkit Strategy Group (TSG) until it is released to the public on the Toolkit website. The first formal step is when the Product Manager submits a brief Product Plan outlining what the product is and the strategy for developing and testing software and delivering documentation and training material. Based on the plan the TSG assesses the product and decides if the product is appropriate.

Then the hard work starts agreeing on intellectual property rights, writing a licence agreement, writing software, writing documentation and preparing training material. Then the most important step of testing the software, documentation and training material. This is to ensure that the code is robust and produces defensible results. TIME based code must also have a common look and feel so that users are comfortable with using new products. The documentation is required to be sufficient to use the product and should be written in a standard

## NEW SOFTWARE VERSION

### Rainfall Runoff Library (RRL)

Version 1.0 of the Rainfall Runoff Library software is now available from the Catchment Modelling Toolkit web site at www.toolkit.net.au

The user manual and software has been updated in response to feedback from users since the Catchment Modelling School in February 2004. This version replaces the earlier beta versions available through the Toolkit web site.

There is no cost to obtain the RRL software but you must be a registered member of the Catchment Modelling Toolkit.

**For further information about the RRL update please visit www.toolkit.net.au/rrl**

# TIME TRAINING WORKSHOP

**A TIME training course is scheduled for 16-17 September 2004 in Canberra.**

This two-day course covers the development of environmental models and modelling applications within The Invisible Modelling Environment (TIME). TIME is a modelling and programming system for rapidly developing, applying and deploying environmental models. The programming languages used are C#, VB.NET or Lahey Fortran 95.NET.

The TIME workshop led by Nick Murray and Joel Rahman costs $880 (inc. GST) or $660 concession for CRC Party and Affiliate staff.

**For further information and to register on-line please visit www.clw.csiro.au/conferences /time/index.html**

template. The training material must be tested in a workshop or possibly with students working through the examples and reproducing the results. We feel that all of this is essential for any product that is on the Toolkit website so that users perceive our site as one that delivers quality software. We want people to keep coming back to our site and providing quality software that meets users' needs is our strategy to make this happen.

With the hard work done, the fun starts in getting the product ready for release. A hidden product area is created from a standard template on the Toolkit website. This template is completed by the Product Manager editing the pages via the web. The product is then bound into an installer, compressed into a zip file and uploaded to the hidden product area. A test download and final check is made and then the product page is exposed. Registered users are then notified by a news item of the new product and the distribution proceeds.

The Product Manager can then monitor the progress of downloads via a web-based reporting facility. The Product Manager will also monitor and coordinate responses to bugs and e-groups.

*Supporting Product Managers*

As you can see there is a lot to be done to get a product on the website. A lot of this work rests with our Product Managers. To make this easier the CRC offers a lot of support, such as:

- Standardised templates for documentation, web pages and licence agreements.
- Standardised graphic images for installers, splash screens, about screens and documentation covers.
- Web page editing and documentation layout support. Web pages can be accessed by Product Managers and updated as required.
- Training and support in the use of TIME, documentation templates and the use of the website.
- Product Manager workshops. This aspect of the CRC has grown considerably over the last 18 months to meet the needs of high quality products.
- Reports on downloads

*Some personal experience*

I am a Product Manager for the Rainfall Runoff Library (RRL) and consequently have first hand experience in what is required of a Product Manager. I know that it is quite difficult to get a product ready for the Toolkit, but very easy to distribute and maintain when in the Toolkit. A new version of the RRL was released and within a day 40 people had downloaded the new version; a week later 204 people had downloaded RRL. It astounded me how many people use the software, and also how quickly this can happen with minimum input from me. This is one of the strengths of the Toolkit and a good reason for going through the rigorous process to get a product on the site.

*The Catchment Modelling Toolkit*

In the November, 2002 *Catchword* I wrote an article that was a vision for the Catchment Modelling Toolkit. It is interesting to look back at this article and see how far we have come. The Toolkit is definitely much more than I had in envisaged back then. Currently there are 1705 Toolkit members and the list is growing by about 30 members a week.

We recently had some feedback from one of our Toolkit members who was amazed that we were offering quality software for free. He had some difficulty in convincing his colleagues that something so good was free.

If you are not a Toolkit member maybe you would like to join. This is as easy as going to our website (www.toolkit.net.au/register) and signing up as a member. There are a lot of new things that will be released over the next year and as a Toolkit member you will be kept up-to-date with the latest releases.

If you are an existing member and have downloaded a product, if you haven't already signed up to the relevant e-group please do, and participate in some discussions about the product. We appreciate feedback about our products as this helps to guide us in product development.

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PROGRAM 2

## LAND-USE IMPACTS ON RIVERS

Program Leader
PETER WALLBRINK

### Report by Ruth Duncan, Matthew Bethune, Evan Christen and John Hornbuckle

### Reducing the impacts of irrigation and drainage on river water salinity – Project 2.19 (2A)

*Salt mobilisation processes and management in irrigated areas*

CRC for Catchment Hydrology Project 2.19 (2A) focuses on the impacts of irrigation and drainage on river water salinity.

This project requires the identification of the major salt mobilisation processes affecting irrigation drainage salinity for the development of sound modelling tools for use specifically in irrigation areas. Understanding gained from this project will be used to investigate management options to reduce impacts of irrigation drainage on river water salinity.

A key output of the project is the development of an irrigation and drainage module for the E2 modelling framework to allow a simple description of irrigation as a land use in the whole-of-catchment context. At this stage, the module for E2 will represent irrigation areas as a single land use or Functional Unit (FU) as described by Robert Argent in the May 2004 *Catchword* article. Multiple nodes representing multiple FU's, can be accommodated in the node-link style E2 model for a greater level of detail within irrigation areas if data permits. Software planning for the integration of the irrigation and drainage module into E2 is now underway.

Behind every robust modelling framework is a sound scientific understanding of the physical processes. Initial investigations identifying conceptual hydrogeological settings of irrigation areas in Australia to underpin this understanding were outlined in the November 2003 *Catchword*. This work has now been consolidated into a review of published literature identifying dominant salt mobilisation processes and management options within major irrigation areas in the Murray Darling Basin (MDB). A summary is given below.

*Salt mobilisation in irrigation areas*

Water percolating past the root zone has led to shallow watertables and is a major cause of salt mobilisation. Once mobilised, salt fluxes are transported to surface drainage and river systems through the following processes:

- salt washoff
- sub-surface drainage (engineering)
- groundwater seepage
- channel outfalls

*– Salt washoff*

Conceptually, two sources of salt contribute to salt loads in surface runoff in irrigation areas. The first source consists of salt supplied in irrigation water and rainfall. This source is more important in areas with high salinity levels in irrigation water salinity resulting from groundwater reuse or saline delivery water.

The second source consists of salt pickup from the soil. Salt pickup occurs in overland flow associated with both irrigation and rainfall. The magnitude of salt pickup increases when soil salinity increases. This process is characteristic of the Kerang and Wakool areas which have large areas with shallow watertables and highly saline surface soils.

*– Groundwater seepage*

High watertables can result in groundwater discharge to surface water features such as depressions, open drains, streams and creeks. Accessions under irrigated areas can create large areas with high watertables, potentially increasing the gradient, seepage and salt transport between the groundwater and river system. Large gradients between groundwater and river systems are typical in areas with incised rivers, such as along reaches of the lower Murray. Sunraysia region has a salt mobilisation rate of 10 T/ha/yr, the highest rate within all areas included in the study. Over 90 % of salt mobilised in the Sunraysia irrigation area is attributed to groundwater seepage. Groundwater seepage was also found to be a dominant process in areas with deep surface drains, as found in parts of the Kerang Irrigation Region.

*– Engineered subsurface drainage*

Sub-surface drainage is required to manage water logging and soil salinity in areas of high watertables with high value industry within the MDB. The two main forms of sub-surface drainage implemented in irrigated areas are horizontal drains and vertical tube well or spear point systems. Management of the drainage systems heavily influences the amount of salt mobilised to surface drainage systems. For example, the highest rates of subsurface drainage occur under tile drainage in the horticultural land in the Murrumbidgee Irrigation Area with over 2 T/ha/yr of salt discharged directly into surface drains. Horticultural land represents less than 10 % of the total irrigated area in the region highlighting the potential to achieve reductions in salt loads from irrigation areas by improved subsurface drainage management and design in specific areas.

## NEW TECHNICAL REPORT

### Estimating Extractable Soil Moisture Content for Australian Soils

**By**

**Tony Ladson**
**James Lander**
**Andrew Western**
**Rodger Grayson**

**Technical Report 04/3**

This report uses an unconventional approach to estimating plant available water content for Australian soils. Instead of using laboratory measurements of soil properties, the authors have collected actual measurements of soil moisture from a wide range of field studies around Australia.

In total, extractable soil water capacity is presented for 180 locations that include the six States and two Territories. The report also compares estimates of extractable soil moisture from field measurements with those from the Atlas of Australia Soils.

**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**

## CRC WEB SITE UPDATE

The CRC web site at www.catchment.crc.org.au has recently been redesigned and updated. The new site contains additional information about our research outcomes from 1999-2002 as well as the current round of CRC projects.

The new site includes past copies of Catchword, all CRC publications since 1999, a contact directory for CRC staff, news and events pages and a Google powered search engine that includes Adobe Acrobat files.

**Further information and project reports will also be added over the coming months.**

**For further information contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au**

*– Channel outfalls*

Overflow from the irrigation supply system can directly enter the surface drainage system through channel outfalls. Channel outfalls are typically a small source of salt within irrigation areas due to typically low volumes and low salinity concentrations (0.1 - 0.8 dS/m). Channel outfalls often reduce salinity levels in drains, making the water more suitable for diversion for consumptive use. Increased channel water salinity can occur when sub-surface drainage water is pumped directly into the channel system or there is direct groundwater seepage into the channel system.

*Overview of salt mobilisation data*

Total salt loads from irrigation areas in the MDB vary between 0.04 and 10 T/ha/yr (Table 2.1). The variation in salt load is associated with the hydrogeological setting of each region. There is also considerable variability in salt mobilisation within irrigation areas, which appears to be influenced by the current management and operations within the area.

*Salt export from irrigation areas*

The available data indicates that large reductions in the salt load from many irrigation areas in the Murray Darling Basin have occurred over the last 10-20 years. These reductions are associated with a combination of management and climatic influences. Separation of climatic and management influences is difficult. Limited data sets are available with sufficiently long record periods to allow rigorous model testing to identify the dominant influences. Consequently, some caution is warranted in the interpretation of modelling studies of salt mobilisation and export from irrigation areas.

There is scope to reduce salt export from irrigation areas. Retaining additional salt within most of the irrigation region should not have a substantial impact on groundwater quality or root zone salinity over the next 100 years. Localised productivity and environmental implications of increasing salt storage need further consideration.

Options for managing salt disposal from irrigation areas include:

i) source reduction through improved irrigation efficiency

ii) source reduction through improved sub-surface drainage

iii) improved drain efficiency

iv) diversion of drainage away from streams.

*Table 2.1. Modelled annual salt mobilisation to drains in different irrigated catchments. [1](Sinclair Knight Merz 2003b); [2](Coleambally Land and Water Management Plan Committee 1996); [3]; (van der Lely 1994); [4](Mudgway et al. 1997) [5](Gilfedder et al. 2000), This study did not measure rainfall washoff; 6(Sinclair Knight Merz 2003a).*

| Irrigation area | Area | Salt washoff | | Groundwater seepage | | Sub-surface drainage | | Channel outfalls | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ha | ML/ ha | T/ ha | ML/ha | T/ ha | ML/ ha | T/ ha | ML/ ha | T/ ha | ML/ ha | T/ ha |
| **Shepparton Irrigation Region** | | | | | | | | | | | |
| Toolamba[1] | 3,000 | 0.24 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.04 |
| Murray Valley[1] | 19,100 | 1.27 | 0.23 | 0.02 | 0.02 | 0.03 | 0.05 | 0.19 | 0.01 | 1.51 | 0.31 |
| Upper Deakin[1] | 16,000 | 0.97 | 0.26 | 0.04 | 0.10 | 0.09 | 0.30 | 0.04 | 0.00 | 1.15 | 0.66 |
| Lockington[1] | 26,400 | 0.42 | 0.14 | 0.02 | 0.05 | 0.01 | 0.02 | 0.14 | 0.01 | 0.59 | 0.22 |
| SIR Average[1] | | 0.80 | 0.19 | 0.02 | 0.05 | 0.04 | 0.10 | 0.12 | 0.01 | 0.98 | 0.35 |
| **Murrumbigee/Colleambally Irrigation Area** | | | | | | | | | | | |
| CIA [2] | 79,000 | 0.80 | 0.17 | na | na | 0 | 0 | 1.24 | 0.1 | 2.04 | 0.18 |
| MIA [3] | 207,500 | 0.47 | 0.10 | 0.005 | 0.002 | 0.07 | 0.15 | 0.53 | 0.05 | 1.07 | 0.30 |
| MIA - farms without subsurface drainage[3] | 188,000 | 0.42 | 0.10 | - | - | - | - | na | na | 0.42 | 0.10 |
| MIA - farms with subsurface drainage[3] | 15,000 | 1.2 | 0.13 | - | - | 0.97 | 2.12 | na | na | 2.17 | 2.25 |
| **Kerang Irrigation Region** | | | | | | | | | | | |
| Calivil creek[4] | 46,500 | 1.86 | 3.58 | 0.01 | 0.17 | 0.00 | 0.00 | 0.00 | 0.00 | 1.87 | 3.74 |
| Drain 14[5] | 2,700 | na | 1.60 | na | 4.60 | 0.00 | 0.00 | na | na | na | 6.20 |
| **Sunraysia Region**[6] | 10,974 | | | 0.36 | 9.20 | 0.96 | 0.91 | na | na | 1.32 | 10.11 |

There is a direct trade-off between management options influencing changes in salt mobilisation processes. For example, reducing sub-surface drainage will likely lead to larger areas with saline soils, which will lead to increased salt washoff. The interactions between salt mobilisation processes is, at best, understood on a conceptual level only, quantitative assessment of the interactions remains difficult.

*Further Information*

A more detailed discussion is provided in the CRC Technical Report 'A review of salt mobilisation and management in irrigated areas of the Murray Darling Basin' to be available shortly through the CRC for Catchment Hydrology website.

*References*


Coleambally Land and Water Management Plan Committee (1996) 'Colembally Land and Water Management Plan.' (Dept Water Resources, Coleambally)

Gilfedder M, Mein RG, Connell LD (2000) Border irrigation field experiment. 2: Salt balance. Journal of irrigation and drainage engineering 126, 92-97.

Mudgway LB, Nathan RJ, McMahon TA, Malano HM (1997) Estimating salt loads in high watertable areas. 1: Identifying processes. Journal of irrigation and drainage engineering 123, 79-90.

Sinclair Knight Merz (2003a) 'Integration and Optimisation of Salt Interception in the Sunraysia Region.' (Department of Land and Water Conservation (NSW),

Sinclair Knight Merz (2003b) 'Shepparton Irrigation Region Salt Disposal Entitlement Review.' (Sinclair Knight Merz, Melbourne)

van der Lely (1994) 'Evaluation of watertable control options MIA Land and Water Management Plan.' (Dept Water Resources, Murrumbidgee Region).



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PROGRAM 3

# SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

## Report by Bofu Yu and Jackie Robinson

### Input-output analysis for the Murrumbidgee and its integration with water trading simulation in WRAM

*Background*

Project 3.08 (3A): 'Hydrologic and economic modelling for water allocation' is about developing methodology and models to simulate temporary and permanent water trading at the catchment scale and to evaluate the impact of water trading on regional economy. The methodological framework for impact assessment is input-output analysis.

*Input-output analysis*

Input-output is essentially a method of compilation which describes the inter-dependence of industries in terms of the flow of goods and services. It is rich in detail and captures the structure of the national and regional economy. Input-output framework has been used in the System of National Accounts published by the United Nations for checking the consistency of national accounts and for providing a detailed basis for analysing industries, products, and other economic relationships. Input-output is also the framework of accounts used at both State and Federal levels in Australia.

*Water accounts*

Water accounts describe the physical flow of the water resources from the environment through various economic sectors. In Australia, water accounts consist of water supply and use tables according to the Input-Output Broad Industry Group (IOBIG) classifications. This classification allows physical data on water to be matched with monetary/economic data available at the same level of detail. Water accounts are part of a broader environmental accounting framework. Adoption of water accounts for the CRC Focus Catchments is arguably the only way to rigorously tie together water and economic data in one consolidated database.

*Project approach*

For the CRC project 3.08 (3A), we have developed software known as WRAM (Water ReAllocation Model) to simulate water trading among IQQM and/or REALM irrigation demand nodes at a range of time scales (Yu *et al.*, 2003). Flow of water to different agricultural

## NEW TECHNICAL REPORT

### Nature, Preparation and Use of Water Accounts in Australia

**By**

**Manfred Lenzen**

**Technical Report 04/2**

This report on the nature and use of water accounts reviews major research activities and outcomes in this important area, especially the work carried out at the Australian Bureau of Statistics, CSIRO and University of Sydney in Australia. The report outlines the methodology to integrate water accounts into input-output transaction tables for water multiplier calculations, and highlights the data-intensive nature of input-output analysis and spatial issues associated with regional water accounts and input-output tables.

**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.pdf download from www.catchment.crc.org.au/publications**

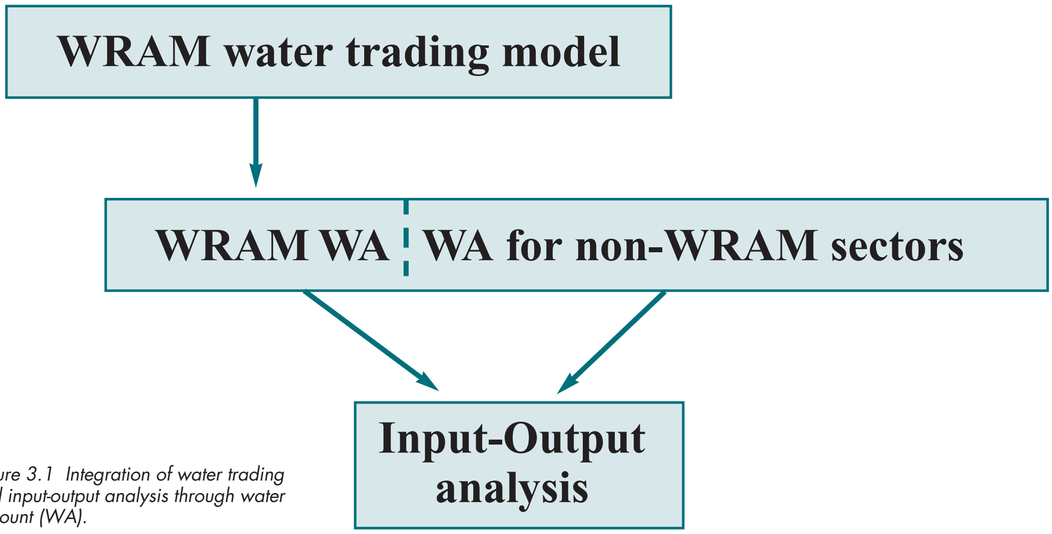


*Figure 3.1 Integration of water trading and input-output analysis through water account (WA).*

sectors in the form of an incomplete water account can be generated for different water trading scenarios. These partial water accounts are combined with those for the rest of economy to create water accounts for the whole catchment. Water accounts in physical units (eg. ML) can be integrated with input-output transactions table in monetary units to evaluate the impact of water trading on regional economy. A schematic diagram (Fig. 3.1) below shows how the water trading module is integrated with input-output analysis through water accounts in WRAM. Table 3.1 shows the 28 industry sectors in the Murrumbidgee and their gross outputs and multipliers based on ABS data and local surveys for the period 2001-2002. A more detailed CRC technical report on input-output analysis, water account and integration with water trading simulations is being prepared.

*Reference*

B. Yu, J. Tisdell, G. Podger, and I. Salbe. 2003. A hydrologic and economic model for water trading and reallocation using linear programming techniques, MODSIM2003, pp. 965-970.

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*Table 3.1. Total industry output from 28 sectors in the Murrumbidgee catchment and the corresponding multipliers for 2000-2001.*

| | INDUSTRY | Output ($000) | Multipliers |
|---|---|---|---|
| 1 | Sheep Meat | 127,248 | 1.68 |
| 2 | Wool | 431,488 | 1.49 |
| 3 | Beef Cattle | 178,343 | 1.32 |
| 4 | Intensive Animals | 72,832 | 1.71 |
| 5 | Grapes | 127,464 | 1.53 |
| 6 | Citrus | 78,459 | 1.25 |
| 7 | Vegetables | 103,373 | 1.51 |
| 8 | Other Horticulture | 54,831 | 1.42 |
| 9 | Rice | 201,008 | 1.48 |
| 10 | Other Crops | 1,079,449 | 1.44 |
| 11 | Other Agriculture | 193,480 | 1.21 |
| 12 | Forestry/Fishing | 90,325 | 1.3 |
| 13 | Mining | 16,933 | 1.36 |
| 14 | Meat Processing | 204,597 | 1.75 |
| 15 | Rice Milling | 479,000 | 1.72 |
| 16 | Wine Production | 517,994 | 1.56 |
| 17 | Fruit/Veg Processing | 153,550 | 1.61 |
| 18 | Other Food Manufacturing | 83,200 | 1.9 |
| 19 | Wood/Paper Products | 292,413 | 1.48 |
| 20 | Other Manufacturing | 108,538 | 1.23 |
| 21 | Electricity/Gas | 206,992 | 1.23 |
| 22 | Water/Sewerage | 801,590 | 1.39 |
| 23 | Building Const | 998,701 | 1.2 |
| 24 | Trade | 1,033,687 | 1.07 |
| 25 | Transport/Communication | 613,450 | 1.17 |
| 26 | Finance | 825,540 | 1.04 |
| 27 | Other Services | 1,437,735 | 1.05 |
| 28 | Tourism/Recreation | 431,640 | 1.3 |
| | **Grand total** | **10,943,860** | |

PROGRAM 4

**URBAN STORMWATER QUALITY**

Program Leader
TIM FLETCHER

## Report by Tony Ladson, Chris Walsh, and Tim Fletcher

### Is reducing runoff frequency the key to restoring urban streams?

*Background*

In the December 2003 issue of *Catchword*, we wrote about improving stream health by decreasing the connections between impervious surfaces and waterways. Since then, we have developed an approach to selecting those Water Sensitive Urban Design techniques that will have the greatest influence on stream health. We are using this information to design a large scale experiment in stream restoration that we are hoping to gain support for.

As we discussed in the December 2003 article, recent work has shown that stream health is strongly influenced by the proportion of a catchment that consists of impervious surfaces that are drained to streams via stormwater pipes. A major effect of efficient drainage of impervious surfaces is to increase runoff frequency. A few millimetres of rain falling on a car park, road, or roof will be sufficient to cause surface runoff that will flow into entry pits and then to streams via the urban drainage network. The same piped network will also efficiently deliver any chemical spills directly to streams in dry weather.

*Urbanisation causes increased runoff frequency*

To quantify the change in runoff frequency following urbanisation, we estimated the frequency of surface runoff from a 600 $m^2$ house block in the Dandenong Ranges using a simple rainfall-runoff model (Chiew and McMahon, 1999). In the pre-urban, forested condition, about 15 mm of daily rainfall on average is required to produce runoff from the 600 $m^2$ block. Runoff is generated on approximately 4% of days (i.e. there is 15mm or more rain on an average of 15 days per year), most of these occurring during the wettest months of September-November. Introducing impervious surfaces dramatically increases runoff frequency. Assuming that it takes 1 mm of daily rainfall to produce runoff from impervious surfaces, such surfaces will produce runoff on about 33% of days (i.e. there is 1mm or more of rain on an average of 120 days per year), spread more evenly through the year.

*Stream disturbance is increased*

If multiple impervious surfaces were connected to the stream by stormwater pipes (as is the traditional approach to stormwater management), then runoff from these more frequent smaller storms of less than 15mm would be directly delivered to streams. The stream disturbances from these events would result from the interaction between the hydraulic/physical disturbance, and the chemical/contaminant impacts. Such frequent disturbances can explain the changes that have been observed in macroinvertebrate and diatom assemblage composition (Walsh 2004, Newall and Walsh in press), while frequent pulses of high nutrient water could explain the observed increased biomass of benthic or bottom dwelling algae in streams (Taylor *et al.* 2004).

*Urbanisation lowers baseflows and increases the risk to streams from chemical spills*

A secondary effect of increased runoff from impervious surfaces delivered to the stream by pipes is the reduction of infiltration, and the lowering of the water table and baseflow. Lower water tables tend to reduce baseflow and increase retention time of high nutrient storm inputs. Increased retention time in concert with increased algal growth can lead to nocturnal oxygen depletion. The direct connection of impervious surfaces to streams also increases the risk of toxicity occurring from spills in the catchment between rain events.

*Quantifying urbanisation impacts with a drainage connection index*

We have developed a drainage connection index, CI, that describes the extent that runoff frequency has been modified by development. This index, which is based on the frequency of occurrence of daily rainfall totals, depends on the climate and soil characteristics of a particular location and can be estimated using a calibrated rainfall runoff model (Walsh *et al.* in review). The drainage connection index for the area near Croydon (a suburb in Melbourne's east) is shown in (Figure 4.1). Under natural conditions the first 15 mm of rainfall will be retained - which corresponds to a drainage connection index of zero (CI =0). For an impervious surface directly connected to a stream by pipes, only about 1 mm of rain will be required to produce runoff (CI =1).

*Using WSUD to decrease runoff frequency*

To reduce effective imperviousness, water sensitive urban design measures need to be implemented to retain rainfall and reduce the connection index, CI. If dispersed, small-scale stormwater treatment were applied with the aim of intercepting rainfall of up to 15mm in the urbanised catchment, then impacts to the stream resulting from stormwater runoff would be restricted to larger rain

## NEW TECHNICAL REPORT

### Integrated Stormwater Treatment and Re-use Systems - Inventory of Australian Practice

**By**
**Belinda Hatt**
**Ana Deletic**
**Tim Fletcher**

**Technical Report 04/1**

The aim of this research was to develop an inventory of technologies for the collection, treatment, storage, and distribution of general urban stormwater runoff and, where current knowledge allows, provide interim guidance on stormwater re-use implementation.

**Bound copies of this report are available from the Centre Office for $27.50 (include GST and postage and handling).**

**Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au for further information.**

# URBAN STORMWATER SOFTWARE

## Model for Urban Stormwater Improvement Conceptualisation (MUSIC) version 2

**MUSIC** is a decision-support system. The software enables users to evaluate conceptual designs of stormwater management systems to ensure they are appropriate for their catchments. By simulating the performance of stormwater quality improvement measures, music determines if proposed systems can meet specified water quality objectives.

**MUSIC Version 2 is available as a free evalution Version download from the Catchment Modelling Toolkit website at www.toolkit.net.au/music**

**The MUSIC evaluation version allows you to trial the MUSIC software for 6 weeks. During that period you are able to purchase the MUSIC software for $330. Discounts apply if you a current MUSIC version 1 user.**

**For further information visit the MUSIC web site at www.toolkit.net.au/music**

**Please note: You must be a registered Catchment Modelling Toolkit member to download the MUSIC evaluation version.**

events. Since the aim is to store, infiltrate, reuse, evaporate, or transpire this retained rainfall, it will be most feasible to undertake works at a small scale near the source of runoff. Large, downstream treatment measures are unlikely to be feasible for decreasing the connection index because of the volume of water involved.

While increased total catchment imperviousness would still cause flows from larger rain events to be greater and more intense than those of the pre-urban state (and probably associated with higher levels of pollutants), the timing of these events would be in line with the pre-urban stream. The ecological impacts of these larger events may be relatively small, because they are closer to the type of disturbance to which plant and animal life that live in flowing water (lotic biota) are adapted.

*Summary*

Our proposed approach to restoring urban streams is to develop a new type of urban drainage system that reduces the runoff frequency from urban areas closer to what it would have been under natural conditions. This means that some of the rain that would have produced runoff from an impervious surface must, instead, be intercepted. The intercepted water is infiltrated, evaporated, transpired or stored for later household use. Larger events will still cause runoff, and therefore disturbance to stream biota, but at a frequency that is closer to natural conditions. Making the drainage system less hydraulically efficient will also protect streams from chemical spills.

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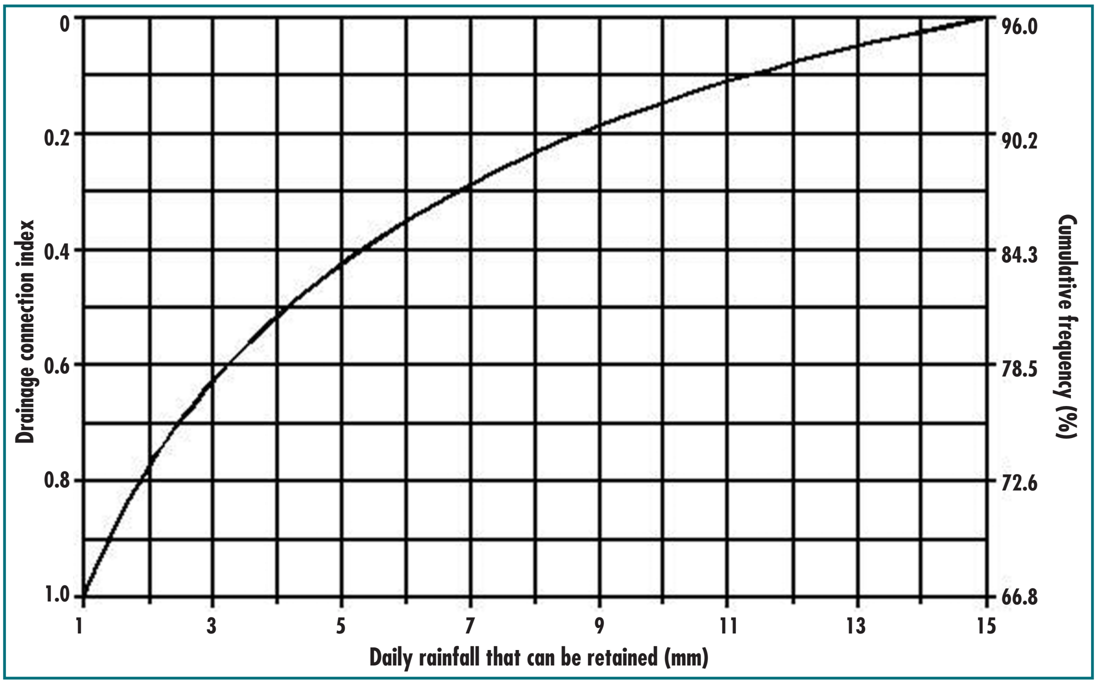


*Figure 4.1 Drainage connection index, CI for the Dandenong Range, Victoria Australia, where the first (approx.) 15 mm of rainfall is retained under natural conditions.*

PROGRAM 5

**CLIMATE VARIABILITY**

Program Leader
FRANCIS CHIEW

### Report by Francis Chiew

#### Stochastic Climate Library (SCL)

*Overview of SCL*

The Stochastic Climate Library (SCL) is a model/software product, and can now be downloaded from the CRC's Catchment Modelling toolkit website www.toolkit.net.au. SCL provides a library of stochastic models for generating climate data. SCL was produced in the CRC's stochastic climate data generation projects (Project 5.2 and Project 5.06 (5B)) which involved the development and testing of stochastic data generation models by CRC for Catchment Hydrology staff in collaboration with other researchers.

The current version of SCL has stochastic models for generating rainfall and climate data at a site at annual, monthly and daily time steps. Other stochastic models will be added to future versions of SCL, after model development and testing. The product manager of SCL is Sri Srikanthan.

*Why SCL?*

SCL is designed for hydrologists, environmental scientists, modellers, consultants and researchers to facilitate the generation of stochastic climate data.

*What are stochastic climate data?*

In short, stochastic climate data are random numbers that are modified so that they have the same characteristics (in terms of mean, variance, skew, long-term persistency, etc…) as the historical data from which they are based. Each stochastic replicate (sequence) is different and has different characteristics compared to the historical data, but the average of each characteristic from all the stochastic replicates is the same as the historical data.

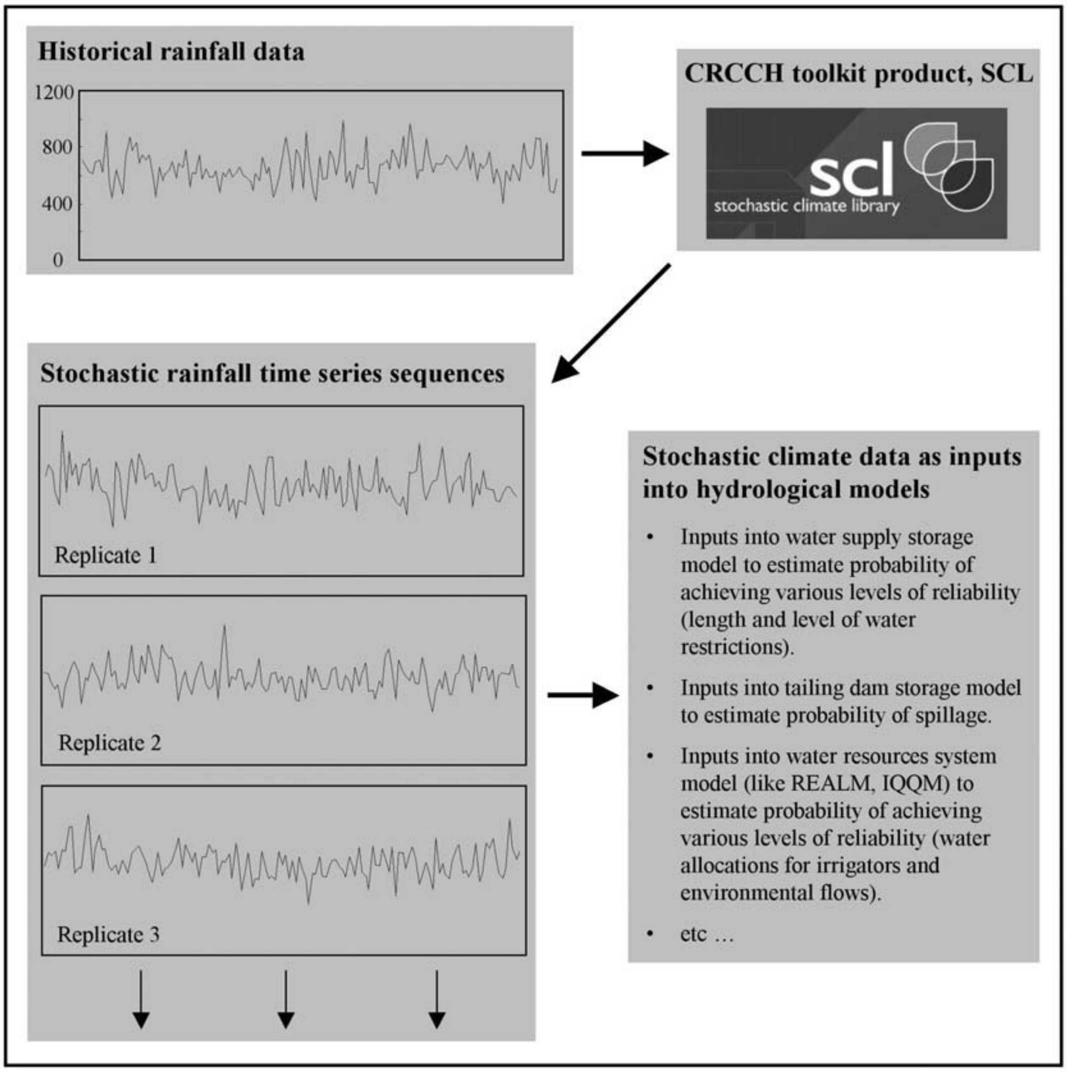


*Figure 5.1 Using stochastic climate data as inputs into hydrological and ecological models to quantify uncertainty in environmental systems associated with climate variability*

## NEW TOOLKIT SOFTWARE

### Stochastic Climate Library (SCL)

The Stochastic Climate Library (SCL version 1.0.3b) and its associated user guide can now be downloaded from www.toolkit.net.au/scl For details of changes made to this version of SCL please look under 'Version History' on this page.

Stochastic climate data can be used as inputs into hydrological and ecological models to quantify uncertainty in environmental systems associated with climate variability.

SCL is a library of stochastic models for generating climate data. Version 1.0.3b of SCL has stochastic models for generating rainfall and climate data at a site at annual, monthly and daily time steps. Other stochastic models will be added to future versions of SCL, after model development and testing.

**For further information about SCL and its application visit www.toolkit.net.au/scl**

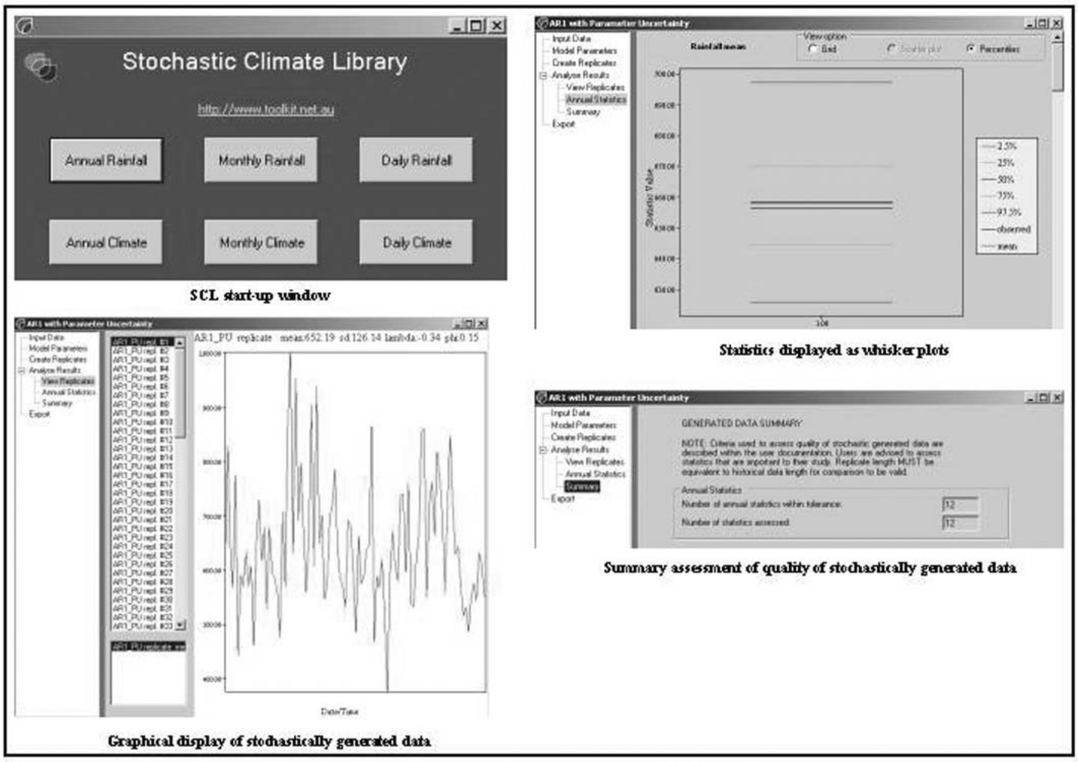


*Figure 5.2 Screen captures showing some examples of SCL user interface*

*Why use stochastic climate data?*

Using historical climate data as inputs into hydrological models provides results that are based on only one realisation of the past climate. Stochastic climate data provide alternative realisations that are equally likely to occur, and can therefore be used as inputs into hydrological and ecological models to quantify uncertainty in environmental systems associated with climate variability (see Figure 5.1). Stochastic climate data are traditionally used in storage yield analysis to estimate reservoir size for a given demand and reliability, or to estimate system reliability (number and levels of water restrictions) for a given storage size and demand characteristics. Stochastic climate data can also be used as inputs into water resources models (such as REALM and IQQM) to estimate system reliability (e.g., water allocation for competing users) for alternative allocations rules and management practice.

*Features of SCL*

- SCL is easy to use and is based on relatively robust stochastic climate data generation models. [Although stochastic hydrology is a mature science, new stochastic models are continually being developed, usually with marginal improvements on previous models. The models in SCL are selected because of available expertise, their robustness, and extensive and successful model testing using data from across Australia].
- SCL requires a historical time series as input data. Various time series data formats are supported by SCL (and other models in the modelling toolkit) (screen captures in Figure 5.2 show some examples of SCL user interface)
- SCL has a user-friendly interface and runs quickly from a PC (personal computer).
- SCL displays the input time series and stochastically generated data graphically.
- SCL displays the statistics of the stochastically generated data and historical data, and provides a summary assessment of the quality of the stochastically generated data.
- SCL allows easy retrieval of the stochastically generated data and the summary statistics.
- The SCL software and User Guide can be downloaded from www.toolkit.net.au.

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PROGRAM 6

**RIVER RESTORATION**

Program Leader

MIKE STEWARDSON

### Report by Mike Stewardson and Ian Rutherfurd

### Tackling Uncertainty in our Models

*Background*

With increasingly complex environmental system modelling, there is a need to evaluate uncertainty in model predictions because:

i. managers want to know the risks associated with their decisions – these risks include uncertainty in system response

ii. we should be strategic in targeting our research to minimise the major sources of uncertainty in decision-making - these sources can be identified through uncertainty analysis.

*Uncertainty in environmental flows*

We evaluated the uncertainty in one component of an environmental flow regime, the volume of water required to flush fine sediments from a gravel-bed river. Large dams can capture the floods, which leads to fine sediments building up in the channel bed and adversely affecting benthic fauna. In such systems, "flushing flows" can be released from the dam to mobilise bed sediments and flush-out the fine material.

We examined this environmental flow component because it relates to the physical process of sediment mobilisation which has been the subject of extensive research over the last 50 years. As a consequence, we should be well-equipped to estimate the flow required for sediment flushing. In contrast, the knowledge-base to estimate environmental flow components relating to specific ecology linkages is often weak.

*Prediction model*

We constructed a model to predict the volume of water needed to flush fine sediments from a channel. Model inputs were:

(a) the hydraulic characteristics of the river channel

(b) a modelled natural streamflow time-series (because we wanted flushing flows released from the dam to mimic the natural frequency of flushing flows) and

(c) the critical shear stress for mobilising the bed which is estimated from bed sediment size.

As with most models, uncertainties in these inputs relate to possible measurement errors, sampling environmental attributes and uncertainty in model parameters (Table 6.1). We used a variety of techniques to estimate typical uncertainties associated with these inputs.

*Cost of uncertainty*

Because of uncertainties in the model inputs, we can't be certain that the flow estimated by the model will actually turn-over the bed. The cost of this uncertainty is the chance that the bed does not move when the target amount of water is released. If the bed is not turned-over, then that volume of water has been wasted. Similarly, if the bed moves at a discharge below the target discharge, then the extra volume of water released has been wasted. Thus, in this example, we can express the uncertainty in terms of the extra water that has to be released to be confident that the bed will flush. This also allows us to estimate the relative saving in water if managers do various things to reduce the uncertainty.

*Findings from model*

From the model we estimated that 157 Gl/year were needed to mimic the natural frequency and duration of flushing flows. Our uncertainty analysis gives a 90% confidence interval of 350 Gl/year on this estimate! This is a large amount of water by any measure and there are important implications of this uncertainty for those deciding on the environmental flow allocation for this river.

*Table 6.1: Sources of uncertainty in model inputs (the text in italics shows the values used in the analysis)*

| Source of error | Channel Hydraulics | Critical Shear | Flow Regime |
|---|---|---|---|
| **Sampling** | Cross-section sampling (used n=17) | Number of bed particles in sample (used n=100) | Number of years in the record (used n=25) |
| **Measurement** | (Neglected here) | Measurement of grain diameter (± 5 mm) | Error in rating curve ($r^2$=0.95) |
| **Model parameters** | Uncertainty in selecting Manning's n | Dimensionless shear stress from Shield's entrainment function | Estimating flow from ungauged catchments (20% of catchment area) and flow routing |

## CATCHMENT MODELLING SCHOOL 2005

The first preparations are now being made for another Catchment Modelling School in 2005. After the success of the School earlier this year when over 300 participants attended over 500 workshops, the CRC is investigating possibilities of hosting a one week School in both Sydney and Brisbane during May 2005. Further details will be made available as they are confirmed.

**For further information contact david.perry@eng.monash.edu.au**

*Table 6.2 Size of 90% confidence interval (expressed in Gl/year) for volume of discharge required to mimic natural frequency and duration of bed scouring events with one source of uncertainty removed (e.g. if we were completely certain about the hydraulic roughness of the channel, then the confidence interval would be reduced from 350 Gl/yr down to 270 Gl/year, as shown in the bottom left cell of the table)*

| Source of error omitted from analysis | Channel Hydraulics | Critical Shear | Flow Regime |
|---|---|---|---|
| **Sampling** | 280 | 330 | 340 |
| **Measurement** | — | 350 | 350 |
| **Model parameters** | 270 | 320 | 350 |

*Confidence intervals as uncertainty is removed*

Table 6.2 shows the size of this confidence interval if we removed each source of uncertainty. We get the greatest reduction in uncertainty if we removed uncertainty in channel roughness (i.e. Manning's n) and a similar reduction if we remove uncertainty associated with cross-section sampling. Clearly this is where we need to focus our efforts to improve our model predictions. Uncertainty in Manning's n can be virtually eliminated if we calibrate our hydraulic model at a range of discharge. This requires installing stage recorders along the river or surveying the water surface profile at a range of flows. Alternatively we could trial various releases and monitor the effect on bed sediments. There is a cost involved with these additional measurements but these costs will be small compared to the value of water which might be saved (or used more effectively).

*Areas for further investigation*

On reaching this result, we were disappointed at the substantial uncertainty in a relatively straightforward and common environmental flow calculation. However, the discipline of calculating confidence intervals and their potential effect on management decisions has focussed our minds on the problem areas for further investigation. There is an important message from this study - we should plan environmental modelling and data collection in combination to minimise uncertainty in the predicted outcomes of management decisions. Uncertainty analysis can be used to optimise combined data gathering and modelling activities. We are now looking to demonstrate the feasibility and advantages of this approach for a range of environmental systems in collaboration with interested agencies.

Environmental monitoring and modelling are often managed as disconnected activities. Extensive environmental monitoring is undertaken by agencies to evaluate changes in environmental conditions, but the value of these data for reducing uncertainty in environmental modelling is rarely considered. Environmental modellers are used to "making do" with the available data because broad-scale modelling studies rarely include funding for additional data gathering.

*Future practice*

We believe that planning an integrated monitoring and modelling program should be standard practice in environmental management and will lead to significant advances in our confidence in management decisions. This becomes increasingly important as we develop more complex models of environmental response and these models are used to inform major resource allocation decisions. This approach will inevitably require increased investment in environmental data gathering, but this will be repaid with more effective environmental management decisions and greater support from communities affected by these decisions.

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## COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

### The Flow on Effect – July 2004

**At a glance – a summary of this article**

**This month's article looks at the objectives of the CRC's communication and briefly outlines a project that we have established to measure the effectiveness of our communication activities.**

*Our commitment to communication*

The CRC for Catchment Hydrology commits a lot of resources to communication. Our research and support programs all share responsibility to provide relevant and easily understood information about the outcomes of our research to our Parties and the land and water management industry. This commitment is demonstrated by a range of activities:

- *Catchword* (11 issues a year to over 1400 people)
- The CRC web site (recently updated and averaging 3,000 hits per month)
- The Catchment Modelling Toolkit at www.toolkit.net.au (over 1700 registered members and nearly 3000 software downloads)
- The Catchment Modelling School (31 workshops, 300 participants and over 500 workshop places during 9-20 February this year)
- An additional 16 software based training workshops around Australia over the last year
- Technical Reports (almost 100 individual reports published since 1999)
- Industry Reports (3 published since 1999 with another one in preparation)
- A range of public presentations through seminars, conferences, workshops, etc.

At first glance, these figures might suggest a strong level of communication performance. However I'm sure as all *Catchword* readers know, there is an important difference between 'output' and 'outcomes'. The figures above are only outputs. As good as they might look, it is impossible to judge whether the CRC's communication is effective or whether we are all just really busy - they include no measure of impact. As communication is a process to achieve our CRC's objectives, and not the objective itself, then we are faced with how to measure their impact in context of their aim. Which leads me to the question; exactly what is the aim of the CRC's communication?

*Objectives for communication*

In 1999, the CRC committed to an ambitious Business Plan and research program. The Business Plan clearly states that the CRC's key performance indicator "is the level of adoption of our research outcomes". Consequently all of our communication activities are designed to support the adoption of our research outcomes – that is the aim of our communication. Of course our communication must first raise awareness of the issues and our research. It needs to also assist our target audience to understand these issues and the relevance of our research, and establish a level of confidence that the research products we offer are sound and viable tools to enable better catchment management. All of these aspects are not end points in themselves, but are simply prerequisites for the adoption of our research.

*Assessing communication performance*

Clearly if we want to assess our communication performance then it must be done in terms of the Business Plan; it is not something that we can answer ourselves. We have to ask people like you. Some *Catchword* readers may recall that in 2001 we engaged 'Econnect', an independent consultant group, to make an assessment of the effectiveness of our communication activities. Econnect surveyed our *Catchword* readers and the results showed that our efforts were appreciated by our target audience. An overview of the Econnect report was given in the August 2001 edition of *Catchword* and is available in the 2001 archives at www.catchment.crc.org.au/catchword

Three years later and with either one or two years to go, depending on the success of the eWater CRC bid (see the Director's article in this issue), it is an appropriate time to reassess our activities as we enter the final phase of this CRC.

This time we have enlisted the services of a market research group to assess our communication performance. Newton Wayman Chong (NWC) are specialists in this area and their proposed methodology offers us an opportunity to evaluate our communication activities across a number of fronts and determine:

- The adequacy of the level and nature of communication between the CRC and each of its target audiences
- What improvements are required to increase the effectiveness of communications
- The CRC's communication performance relative to the 2001 communication assessment.

*Additional aspects for review*

A number of our communication vehicles such as the Catchment Modelling Toolkit web site

## SPECIAL PUBLICATION AVAILABLE ON-LINE

### Spatial Patterns in Catchment Hydrology

**Edited By**
**Rodger Grayson**
**Günter Blöschl**

This publication (404pp) brings together a number of recent field exercises in research catchments, that illustrate how the understanding and modelling capability of spatial processes can be improved by the use of observed patterns of hydrological response. In addition the introductory chapters review the nature of the hydrological variability, and introduce basic concepts related to measuring and modelling spatial hydrologic processes.

Written in an intuitive and coherent manner, the book is ideal for researchers, graduate students and advanced undergraduates in hydrology, and a range of water related disciplines such as physical geography, earth sciences, and environmental and civil engineering as related to water resources and hydrology.

**This publication can be downloaded at no cost from the CRC web site. Follow the 'Special Publication' link from www.catchment.crc.org.au**

(www.toolkit.net.au) and the Catchment Modelling School have been established since 2001. The assessment will also include these aspects of our communication to ensure that they are as effective as possible and complementing the other communication streams. NWC is a consultancy that works across a wide range of commercial and non-profit sectors. By utilising their experience, we hope to achieve a clear indication of our effectiveness in the broader context of business to business communication.

*We would appreciate your help*

Over the next few weeks, one of NWC's representatives may approach you for your opinion of the CRC's communication. We would sincerely appreciate your time to provide some feedback on our performance. As we near the end of this CRC, it is critical to ensure we have got it right.

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# POSTGRADUATES AND THEIR PROJECTS

## Greg Summerell

For those of you who don't know me, here is a picture of me showing Rising Stage Sample bottles that capture water samples from the rising stage of an event flow.

I'm based out at Wagga Wagga, NSW working for the Department of Infrastructure, Planning and Natural Resources.

Back in July 2000, I started my PhD (with The University of Melbourne) with the CRC for Catchment Hydrology under Project 2.2: 'Managing pollutant delivery in dryland upland catchments'. My Thesis title is "Understanding the processes of salt movement from the landscape to the stream in dryland catchments".

This project involves a field-based study in the Livingstone Creek catchment (~20km2) located within the Murrumbidgee region of inland southern New South Wales where dryland salinity problems are of major concern. The project is designed to investigate and field validate the processes of salt movement from the landscape to the stream. In particular, to identify different hydrological processes operating in the major landforms and link them to the monitored/measured stream salinity patterns. Hillslope hydrology dominates in the sloping landscape whereas in the flat valleys water movement and infiltration is governed more by preferential flow paths. Monitoring salinity mobilisation behaviour within different landforms has provided the knowledge to extrapolate results to other landscapes.

The Livingstone Creek project has been operating since January 2002. Even though a major drought has occurred during this period, I was lucky to get stream salinity observations for four major rainfall events. Preliminary data analysis for the monitored events show that salt delivery patterns to streams have been consistent and repeatable. In the sloping landscapes, stream salinity responses measured at gauging stations showed the classical salinity response to an event. This includes an initial spiking of salinity at the beginning of an event (due to first flush) which then trends to a reduction in salinity (due to dilution) as the event continues. In the flatter alluvial landforms, the salinity response measured at gauging stations shows quite a different pattern as salinity continues to increase with flow.

The salinity responses measured at the gauging stations are supported by unsaturated and saturated zone monitoring of soil moisture and groundwater processes. Additional measurements of surface and groundwater water chemistry, isotopes and soil chemistry were also taken.

The results from this work will influence the way in which we conceptualise and monitor stream salinity problems. This is particularly the case for detailed landscape and stream salinity modelling tools.

Being located in the bush, I have had the advantage of being able to quickly respond to rainfall events and be on site to maintain the field equipment. Due to the nature of data collection in ephemeral streams, when a rainfall event does occur, debris often blocks or impedes monitoring equipment. Therefore maintenance of this equipment required a lot of dedication in cold, wet and windy environmental conditions.

Another advantage is that I am able to communicate directly with extension officers and research results are quickly applied on ground. The Kyeamba Valley Landcare group used results from this PhD to secure funding for land-use change. This outcome was very satisfying as I was able to see my PhD go beyond just being a Thesis, and actually being applied.

I'm currently writing up my Thesis and plan to submit by next month. My PhD supervisors are Prof. Rodger Grayson (Director, CRC for Catchment Hydrology), Dr Narendra Kumar Tuteja (Senior Research Scientist, DIPNR), Dr Glen Walker (Senior Research Scientist, CSIRO). Dr Peter Hairsine (Research Director, Integrated Catchment Management, CSIRO Land and Water) was also heavily involved in the beginning of the research project as the project supervisor.

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# CRC PROFILE

## Our CRC Profile for July is:

### Graham Hawke

The recent publication of the top 100 most influential engineers in Australia not only included 'our' John Langford, but also my first 'boss' and other colleagues. Perhaps more interesting than who's who, were the associated comments which revealed some underlying motivations... sustainability, restoration, environment, justice, humanitarian as well as growth and innovation. Fascinating stuff perhaps?

I like to play chess with my three young children and at work often use chess as an analogy to encourage strategy, and evaluating consequences. However a career is rarely a 'set play' and serendipity can play a large part.

Whilst I aspired to the creativity of architecture, a building slump led to civil engineering being my original degree. I was privileged to specialise in Water and Transport Engineering tutored by mentors such as Russell Mein, Eric Laurenson, Gary Codner, Tom McMahon and Bob Keller as well as Bill Young and other transport luminaries.

Transport was my 'first love' and I initially worked in private consulting, whilst pursuing a related Masters degree. I switched to Local Government at a time when road safety was high on the political agenda. I had fun tackling and beating the State road bureaucracies on innovation with road humps, building 180 in record time, conducting talk back sessions on ABC, and being quietly threatened with jail in the process. These days, the threats come from irrigators experiencing groundwater bans, and meters being installed!

Whilst studying, and being close to a leading Road Research Centre, I was impressed by the knowledge base readily shared, conceptual frameworks, the camaraderie and passion for advancement evident in the leading thinkers...and a commitment to evidence-based decision making, in the midst of a political environment seeking a new silver bullet (to lower the road toll). Seat belts, blood alcohol limits, black spot engineering all made valuable in-roads to reducing the road toll. But it was the multi-disciplinary interventions drawing upon psychology, sociology as much as engineering and having positive financial funding feedback mechanisms that led to real breakthroughs. First love or not, the underlying lessons seem transportable to other sectors.

# PUBLICATION ERRATA

## Hydrological Recipes - Estimation Techniques in Australian Hydrology

It is now eight years since Hydrological Recipes: Estimation Techniques in Australian Hydrology was published by the CRC for Catchment Hydrology and over 690 copies have been sold. During that time users were requested to contact us with feedback and ideas for new topics. While no new topics have been suggested, several errors have been identified. The Errata is available as an Adobe Acrobat pdf from the CRC web site at www.catchment.crc.org.au /news

**The CRC welcomes any other errors that users are aware of. Please contact David Perry on 03 9905 2704 or email david.perry@eng.monash.edu.au**

Local Government being what it is, led me from transport, to waste management, town planning, building and health with roles in Corporate Management at three large metropolitan municipalities including successfully operating in the restructuring and 'outsourcing' phase in Victoria in the early 1990s. Community is at the heart of Local Government, and effective engagement of communities in leading change is the primary skill, and is genuinely rewarding.

I returned to the private sector after a little over a decade, this time what is now KBR, a global subsidiary of US giant Halliburton. (It's rather an odd experience to look up an email address searching from more employees than can fill the Melbourne Cricket Ground!) I had the privilege of working with a visionary leader, pursuing the 'outsourcing' wave in a business development role including facilities management and later managing a joint venture laboratory company. Working closely with three large global companies in joint ventures with a 'can do' attitude must be experienced to be fully appreciated. My best successes derived from general management interventions with joint ventures, leading me to take an interest in a role with what turned out to be a client, in Southern Rural Water (SRW), who manage rural water resources in the lower half of Victoria for some 8,000 customers, including regional urban water authorities and Victoria's power generators.

My career had now turned to the other half of my original training…from transport, to water. I'd also commenced an MBA by distance learning - of which the best advice I received was to start before children demand too much of your time, even if it is to play chess or football. My role as Deputy Chief Executive at SRW has evolved from overseeing technical functions to also encompass the Licensing Business (for my sins) as well as corporate responsibilities. Living in Melbourne yet travelling frequently to rural Victoria into farming communities provides a city and country perspective to the 'environment versus consumptive water use' debate. More importantly, I desire to play my part to facilitate the sharing of knowledge, developing frameworks, and promoting evidence-based thinking to identify the breakthroughs that the political environment seeks. Certainly my experience, and work with the CRC for Catchment Hydrology provides a sound basis for optimism.

To expand upon some brief reflections I made at the CRC's Yarra Valley Annual Workshop – my most valued interaction with CRC - the 'water sector' seems to be in transition, with many eminent leaders moving to new a new stage in their careers. I observe the future influential engineers, scientists, sociologists, economists etc stepping up. When I mix with the many young professionals in the CRC, I am so impressed by the calibre of their work and with their integrity as people. Unquestionably, our future water and natural resource management leaders will be drawn from this group. Others will 'transport' skills and apply their enquiring minds to become leaders in other sectors.

As a closing remark from a lifelong Collingwood supporter, I reflect on 'managing the player list' to ensure there is always young talent being developed to become the future champions. The CRC is so important, because if we don't develop the future influential players, who will?

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## WHERE ARE THEY NOW?

### Report by Muthu Muthukumaran

**Where are they now?**

As I started writing this report, I heard from the School of Graduate Studies, Melbourne University that the examiners have considered that my PhD thesis is worthy for the award of the degree, subject to minor amendments. Like most PhDs, mine also had several anxious moments compounded by some personal problems (I can hear Francis saying "most of them perceived rather than real"), I feel rather relieved that my PhD journey is nearing the desired conclusion.

Many people helped me to reach this stage. Particularly, I would like to thank my supervisors Francis Chiew and Tony Wong for helping me to navigate through the rigours of a PhD, Tim Fletcher who managed to 'find some money' to keep me going in spite of his tight budget, and Rodger Grayson for helping me to take crucial decisions at critical times.

Now, back to the title question, where am I now? I didn't go back to India as I have been telling everyone since the first day I arrived in Australia (most of the overseas postgrads do it anyway). I am still hanging around in Melbourne. I work for City West Water, a water utility in Melbourne responsible for the water supply and sewerage services of the western suburbs including CBD.

At City West Water I am involved with the newly formed water recycling team working on several water recycling projects. The major focus of these projects is to promote the 'fit for purpose' approach which involves substitution of recycled water with potable water, as many of the common uses like garden watering, toilet flushing and some industrial applications do not require drinking quality water. These projects generally concentrate on using treated wastewater from existing domestic wastewater plants.

Water recycling opportunities have also been identified in inner-city areas that are remote from the existing treatment plants and plans are being developed to service these sites using the novel concept of 'water mining'. Water mining involves the installation of a localised treatment plant that extracts and treats sewage from nearby sewers using sophisticated and advanced treatment technologies like membrane filtration and reverse osmosis. I feel very excited to be involved in several challenging projects of this kind that are under various stages of development. If you would like to know more about these projects, please feel free to contact me.

Finally, though I had experience in similar type of projects in India, I should acknowledge that my training at the CRC under 'Australian conditions' was instrumental in getting this job (the interview committee was very impressed when they heard that I have been chasing storms for the past three years!). So fellow postgrads, it is true that we are in high demand!

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## NEW TECHNICAL REPORT

### Analysis and Management of Unseasonal Surplus Flows in the Barmah-Millewa Forest

**By**

**Jo Chong**

**Technical Report 03/2**

This report addresses a major threat to the Barmah-Millewa Forest; unseasonal flooding in the summer and autumn, when the forest would normally be dry. Based on analysis of pre-regulation conditions (1908-1929) and current conditions (1980 - 2000), forest flooding has increased from 15.5% of days to 36.5% of days between December and April.

In particular, small, localized floods, which inundate less than 10% of the forest, occur at least eight times more frequently now, than before regulation. Work by others has related these hydrologic changes to tree death and changes in floristic structure in wetlands.

**Bound copies of this report are available FREE from the Centre Office while stocks last. Contact Virginia Verrelli on 03 9905 2704 or email crcch@emg.monash.edu.au**

**This report is also available as a free Adobe .pdf download from www.catchment.crc.org.au /publications**

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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
Griffith University
Melbourne Water
Monash University
Murray-Darling Basin Commission
Natural Resources, Mines and Energy, Qld
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