NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

# CATCHWORD

NO 123 DECEMBER 2003

## A NOTE FROM THE DIRECTOR

**Professor Rob Vertessy**

**Inside...**



**CATCHMENT MODELLING SCHOOL LAST DAYS TO REGISTER**

**(See Page 15 for details)**

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

## ANOTHER BIG YEAR DRAWS TO A CLOSE

As 2003 draws to a close I am looking back with amazement at what has been a most dynamic year. In this edition of *Catchword*, I thought I'd take a stroll back through the four seasons to re-cap on some of the years big events. Just imagine Vivaldi playing in the background as you read on.

*Summer*

In January we launched our new research portfolio, comprising a $30 million investment in 22 projects to be run over the next three years. Involving 158 staff from 11 organisations, getting these projects underway was a major achievement. All of those projects are now in full flight and starting to yield impressive outcomes. The integrated whole-of-catchment modelling capability that we are striving to build is well within reach. In February we commenced training our Development Project teams, aimed at building catchment modelling capacity in our industry parties. That training has continued throughout the year and we now have a 'crack team' of EMSS model users in the Fitzroy, Brisbane, Murrumbidgee, Goulburn-Broken and Yarra catchments. Early next year, these teams will be given instruction in the use of SedNet, to be followed by training in the use of other models as they come off the 'production line'.

*Autumn*

In March we launched the 'Bushfires and Hydrology' web site (see www.catchment.crc.org.au/bushfires) in response to industry requests for information on the hydrologic impacts of the devastating wildfires in south-eastern Australia. Our CRC received praise from the industry for taking this proactive approach at a time when there was a lot of public confusion about the possible environmental consequences of the fires. In April we held our annual workshop at Yanco in New South Wales. Simply getting there was an epic, but when the 90-odd of us converged on the Murrumbidgee floodplain we had three enjoyable and stimulating days of exchange. Our annual workshop is the lifeblood of the CRC, having both practical communication value as well as a less-tangible celebratory dimension. In May our CRC participated in the CRC Association Conference, working alongside the other four Water Forum CRCs (Freshwater Ecology, Water Quality & Treatment, Wastewater Management & Pollution Control, and Coastal Zone & Estuarine Waterway Management). Our podium presentation made a very positive impact on the audience, highlighting the significant contribution of our Centres to the land and water management debate.

*Winter*

In June we launched the Catchment Modelling Toolkit web site (see www.toolkit.net.au), our prime vehicle for delivering our predictive modelling capability to the land and water industry. This innovative site provides a one-stop shop for end-users seeking access to models. For model developers, the site provides a powerful medium for distributing software, documentation, news and fostering discussion about issues related to the use of models. Gradually, the site is filling up with software products and will soon be regarded as a vital resource for all those working in the catchment modelling arena. In July we inducted four new Industry Affiliates into our CRC. WBM Oceanics, EarthTech, Ecological Engineering and SKM have agreed to work with us to evaluate and promote the use of our modelling tools and to participate in joint consulting and training activities as deemed appropriate. These organisations have each already made a solid contribution to our CRC and we like to think that our output of knowledge and tools is helping them do their business more efficiently, resulting in flow-on benefits for the land and water management industry. In August, our CRC submitted itself to a very rigorous internal review process. A panel of eight specialists scrutinised our portfolio over a four-day period and wrote a comprehensive (and very positive) analysis of our performance. We now look ahead to the all-important fifth-year review of our CRC in July 2004, as mandated by the Commonwealth. I believe we are in a strong position to make a good showing at that review.

*Spring*

In September we commenced the mammoth task of preparing a re-bid for a future CRC for Catchment Hydrology to start in July, 2005. Since the decision to prepare a re-bid proposal was taken, there has been extensive consultation with our existing Parties and prospective new ones. We are working closely alongside the CRC for Freshwater Ecology in the bid preparation process and networking with several re-bidding CRCs. Re-bid planning will continue in earnest until a proposal is submitted to Commonwealth, probably in May, 2004. I'm heartened to say that we

## NEW TECHNICAL REPORT

### The Effect of Afforestation on Flow Duration Curves

By
Patrick Lane
Alice Best
Klaus Hickel
Lu Zhang

**Technical Report 03/13**

This report is part of a series that bridges the gap between the science of catchment water balances and the management of rivers for a range of outcomes by considering the impact of afforestation on flow distribution throughout the year.

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have very strong support from our Parties for a future CRC. Hopefully we will be able to convince the Commonwealth CRC program of the merits of our proposal! In October our CRC was inundated with requests to participate in the plantation water use debate, brought to a head by COAG's announcement of the National Water Initiative. Our scientists have published widely on this issue and we have made quite an impact in bringing into the public debate. We've given briefings to Ministers, Public Service executives and senior managers in natural resource management agencies. We were called upon to give keynote addresses at conferences and to appear before the Senate Inquiry on Rural Water Use. Finally, in December we made a strong showing at the Hydrology and Water Resources Symposium in Wollongong, organised by the Institution of Engineers, Australia. Several participants at this important national conference commented on the growing profile of our CRC in the water industry and the quality of the research we are undertaking. Congratulations to all of our staff and students who contributed to the strong impression our CRC made at the meeting.

*Best wishes for the festive season*

By the time this December edition of *Catchword* hits the streets I suspect that most of you will be preparing to take leave for the Christmas break. If your work has anything to do with land and water management I'm sure that you are relishing the thought of some down time! It's been an amazingly busy year for us all. I hope that you all take a good break and spend lots of time with your family and friends and recharge yourselves.

To those of you involved in the CRC for Catchment Hydrology – thanks for your contributions to what I regard as a very exciting organisation.

To our supporters – thanks for the help you have given us through the year, no matter how minor. Your enthusiasm for the work of our Centre is a vital ingredient in motivating our staff and students to strive for excellence.

To everyone – I hope you have the Merriest of Christmas's and Happiest of New Year's! See you in 2004.

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PROGRAM 1

## PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

### Report by Joel Rahman

**Toolkit 'module' update**

*New arrivals*

Like any good library, the Catchment Modelling Toolkit has a new arrival's shelf, shelves dedicated to holding the dog-eared old favourites as well as a list of new releases expected in the coming months. Today's new arrivals are developing tomorrow's dog-ears before being replaced, down the track, by the hardcover of the next edition.

Our new arrivals shelf is freshly stacked with two products just released to coincide with IEAust's Hydrology and Water Resources Symposium, held in Wollongong over November 10-13. The next major release date is for the Catchment Modelling School (www.toolkit.net.au/school), February 2004, which will include toolkit related versions of Sednet (*Catchword* 107) and the point based stochastic climate generation tools (*Catchwords* 105, 108 and 114).

A new version of MUSIC and a re-engineered EMSS-like model are also in store.

*New releases*

The River Analysis Package (RAP) was released at IEAust's Hydrology and Water Resources Symposium in Wollongong in November. RAP (*Catchword* 116) assists river and water resource managers to undertake condition assessments, environmental flow planning and river restoration design. This is the first of several planned releases of RAP and includes modules for hydraulic analysis of reaches as well as the analysis of various time series. Subsequent versions will include rule based and quantitative models of biological response to flow regime. RAP is now available for download by registered toolkit users from http://www.toolkit.net.au/rap.

Also released in Wollongong is the Rainfall Runoff Library (RRL) (http://www.toolkit.net.au/rrl): an application encompassing a suite of lumped conceptual rainfall runoff models, optimisation tools and sophisticated visualisation capabilities (*Catchword* 114). RRL allows a modeller to select and compare conceptual rainfall runoff models without changing tools or reformatting data. Users can also calibrate each model using one of several automatic calibration tools.

Both RAP and RRL are TIME based products, built using the CRC's library of data handling, visualisation and analysis components. Both product demonstrate the ability of researchers and developers to work together to produce high quality systems with a choice of programming languages. RAP is built predominately in Visual Basic and Java. RRL is built in C# with several models implemented in Fortran 95. RRL and RAP both rely on a large number of built in TIME components developed in C#.

*Coming Soon*

Sednet, a TIME-based, toolkit version of the river basin sediment budget model, is in the late stages of preparation for release by the Catchment Modelling School in February 2004. The toolkit version of Sednet introduces a scenario based interface that allows a user to configure the model in their study area and then examine the effect of land use change on sediment budget.

The Stochastic Climate Library is a collection stochastic climate generation models, resulting from work in Project 5.2 from the first round. The library is also planned for a Catchment Modelling School release and includes models for generating rainfall and other climate variables at daily, monthly and annual time scales. Like RAP, the Stochastic Climate Library is the first release of a system that will subsequently contain models for the generation of spatial daily rainfall (*Catchword* 121).

Both products make use of the visualisation and data handling components in TIME to provide users with a highly visual means of interacting with the system.

*In the Pipeline*

With the release of several products, and several more in the later stages of development, much of Program 1's effort is focussed on 'The Whole of Catchment Prediction Tool (*Catchword* 115). This system represents a node and link network based framework for catchment modelling. Modellers can create 'plug in' modules for nodes and links that represent some element of the biophysical, or economic processes at that point. Examples include:

- plugging in one of the conceptual rainfall runoff models in the Rainfall Runoff Library into a node to predict the runoff from a catchment
- using an in-stream sediment deposition and erosion module from Sednet in the links of the network, or
- driving the system by stochastically generated spatial rainfall

The model has been variously labelled EMSS 2 (to recognise the superseding of EMSS for whole-of-catchment modelling), the New Water Quality Model, the New River Network Model or the River Network Modelling 'Shell' (to represent the fact that it is empty until populated with modules by other projects). It's even been called a skeleton to suggest the structure that it provides to modellers.

The software engineering behind the tool is divided into three parts:

- Development of a sufficiently general spatial structure of nodes and links, including the information channels between elements, to represent the whole of catchment modelling undertaken by the CRC and its collaborators
- Create a high level user interface that allows access to the spatial structure of a system, as well as the individual modules in use
- Develop (incrementally) the required modules, including those emerging from current projects as well as modules that are 'mined' from existing sources.

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# NEW TECHNICAL REPORT

## Estimating Water Storage Capacities in Soil at Catchment Scales.

**By**

**Neil McKenzie**
**John Gallant**
**Linda Gregory**

**Technical Report 03/3**

Landscapes vary in their capacity to store water. Estimates of water storage capacities in soil are required to allow a better analysis of interactions between vegetation and stream flow from local to regional scales. This is particularly relevant to simulation studies relating to dryland salinity, farm forestry and water security. This report investigates how land resource data can be used to improve estimates of water storage capacities in soil at catchment scales.

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# NEW TECHNICAL REPORT

## The Impact of Rainfall Seasonality on Mean Annual Water Balance in Catchments with Different Land Cover

By
Klaus Hickel
Lu Zhang

**Technical Report 03/11**

Our understanding of catchment hydrology is approaching the point where we can confidently predict the partitioning of rainfall and how it changes when we change the land use. This report describes some of the research that supports this important development. By enabling the consideration of seasonality, it enables more confidence in our prediction of how catchment hydrology changes when land use changes.

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PROGRAM 2

# LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

## Report by Peter Hairsine

### Integrated Catchment Management – what is it and what is our role?

Integrated catchment management (ICM) is on often-used term in the land and water industry. In this article I give my view of what ICM is and what the CRC for Catchment Hydrology's role is in this process.

*Definiing ICM*
What is ICM? The use of the word integrated suggests that managers consider all aspects of the catchment. The use of the word catchment suggests that such management recognises the usefulness of hydrologic boundaries in defining the management unit. Management suggests an active process of planning and change within a catchment. So from these words my definition of ICM becomes:

"ICM is to manage catchments so that we recognise the interactions of their components"

*Catchment interactions*
Here a few examples of these interactions, (starting with the simple and becoming more complex):

- Streamflow from upland farms to lowland irrigation areas
- Pollution from one industry impacting on a water user downstream
- Nature reserves providing clean water for downstream use (environmental/ecosystem services)
- Catchment-based water sharing including water trading
- An agricultural downturn making less resources available for land-care work

*ICM and CRC Projects*
The CRC for Catchment Hydrology has several projects that contribute to part of these interactive issues. We also have invested in our Catchment Modelling Toolkit and integration that draws together the various components that we do understand. However, these projects, in isolation, do not permit an ICM approach to catchment management. The research and development is by its nature specialised and addresses only a subset of the social, economic and biophysical issues in catchments. It is for this reason that many of our products are termed "decision support tools" not "decision making tools".

*Limitations of current tools*
A further limitation of our current tools is the understanding and representation of the complex interactions of components of catchment.

Let me give an example suggested to me by Tom Hatton of CSIRO some years ago. If we use our models of water, sediment and nutrients to define an effective approach to improve a catchment's water quality and aquatic habitat, we are guided to improved riparian zone management in small streams. Such improved riparian zones occupy small areas within catchments but provide large downstream benefits. This analysis may be considered "integrated" because of the multiple issues addressed, or the multiple benefits. However, this proposed solution may be flawed if the catchment under consideration is prone to salinity so that over time riparian zones become salt discharge zones. The reality may be that with salinity unchecked, the restored riparian vegetation dies.

This example of interaction is entirely within the scope of the CRC's work but could be missed if our toolkit and integration approach simply served to assemble the lines of research.

*Future progress*
As we assemble our outcomes from our research projects in our Catchment Modelling Toolkit, many other examples of these interactions will emerge. Some of the interactions will require expertise to be applied from outside the CRC teams. Progress will be made through an analysis of such interactions in case studies. Only through this continuous assimilation of our understanding will our tools approach the demands of ICM .

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## Report by David Rassam

### A simple bucket model to evaluate denitrification potential in riparian buffers

*Introduction*
Riparian buffer zones have the ability to intercept nitrate as sub-surface water passes through the carbon-rich root zone. This can reduce nitrate levels in groundwater discharged to streams, thereby contributing to improved water quality. In order to understand and assess the complex processes that take place in these buffers we should closely look at the following:

- Surface water and groundwater interactions.
- Biogeochemical processes such as denitrification that take place under anoxic conditions.

This article reports on the development of a simple bucket model to estimate denitrification potential in riparian buffers. The proposed model is based on a sound understanding of both the hydrology and bio-geochemistry of a riparian buffer, which was gained from Project 2.5, and which is being developed further in Project 2.22 (2D).

*Background*

An experimental field trial was conducted in South-east Queensland, to investigate the mechanisms by which nitrate is transported and transformed in a well-vegetated riparian zone bordering an ephemeral stream. The research has identified that after a rainfall event, surface water enters the riparian zone, infiltrates the floodplain soil, and subsequently forms a perched water table. This perched system provides an anaerobic environment in the carbon-rich root zone, which is a suitable environment for denitrification, a microbial process by which nitrate is transformed into gaseous nitrogen. The denitrification potential of riparian soils was quantified by conducting a laboratory incubation experiment. Groundwater table dynamics were monitored with the aid of fully screened shallow wells and logged pressure transducers. For more details of the site hydrology, see three previous *Catchword* articles (December 2001, June 2002, and June 2003).

*Measurement of Denitrification Potential*

Laboratory measurements of the denitrification potential of riparian zone soils and aquifer sediments were made using the 'acetylene block' technique. Denitrification rates were determined periodically over five days during incubation of soil and sediment slurries under anaerobic conditions at 20°C.

Results of the denitrification assays shown in Figure 2.1 are typical of bacterially mediated reactions where the availability of an energy source (such as organic carbon) plays a major role in determining the reaction rate at any time. Measured denitrification rates obtained from the shallow sediments were assigned to cells 5-8 in the bucket model approach (see following section), while the low rate was set at 50% of the high rate and assigned to cells 1-4. The lower rate was consistent with data obtained from other denitrification assays conducted on soils from deeper layers of the soil profile. A simple polynomial expression was derived to describe the reaction rates during the period from 0 to 4.2 days and was incorporated into the mathematical model.

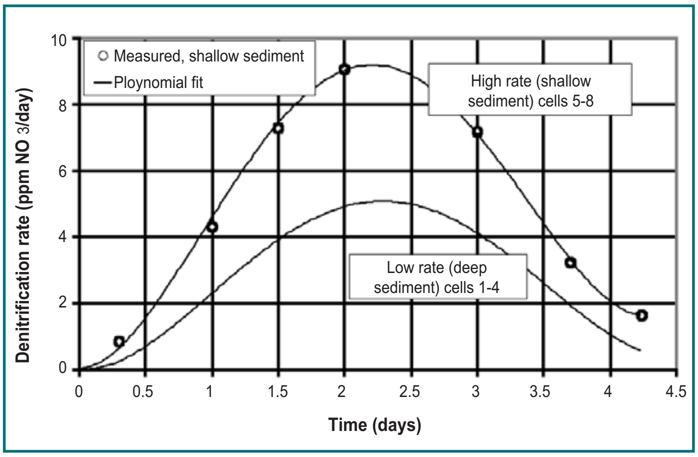


*Figure 2.1: Denitrification rates for two soil zones*

*Model for Estimating Potential Denitrification*

Due to the observed low flow velocities in the floodplain (around 6cm/day), a bucket model approach was considered appropriate for estimating the denitrification potential in the floodplain. That is, a water parcel that enters the floodplain is assumed to remain stationary, it then drains instantaneously when either the stream level drops or stream flow ceases altogether.

The soil profile is divided into 8 discrete buckets, each 5 cm thick and representing an area of 1 $m^2$ of the floodplain. The part of the soil profile under consideration is the hydrologically active zone that extends in this case from 11.5-11.9 m Australian Height Datum (AHD). Figure 2.2 shows the conceptualisation of the bucket model.

As soon as a cell is filled with water, the appropriate denitrification rate is applied and a new nitrate concentration is calculated at 10-minute intervals. The detention time is the period between filling and draining of a cell; when it is long enough, nitrate may be depleted. A cell may be filled more than once during an event; this happens when the stream recedes then rises up again due to further rainfall (see Figure 2.3, time = 0.5-2.0 days). In this case, when a cell re-fills, its storage capacity is halved since some water is usually stored in the unsaturated zone.

*Model Output*

Because the denitrification rate differs with depth (shallow sediment is more active), we introduced the concept of 'effective denitrification rate'; this is a weighted rate based on the water level during any time period. The effective denitrification rate shown in Figure 2.3 (LHS Y-axis) resulted from coupling the groundwater levels shown in Figure 2.3 (RHS Y-axis) and the denitrification rates shown in Figure 2.1. Note that when the groundwater rise coincided with the peak denitrification rate (at 2 days), this resulted in a high effective denitrification rate, highlighting the importance of the interaction between the hydrological and biogeochemical processes.

## MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

### A Critical Review of Paired Catchment Studies with Reference to Seasonal Flows and Climatic Variability.

**By**

**Alice Best**
**Lu Zhang**
**Tom McMahon**
**Andrew Western**
**Rob Vertessy**

**Technical Report 03/4**

This report focuses on the use of paired catchment studies as a means for determining long-term changes in water yield as a result large scale changes in vegetation. Current knowledge gaps in relation to the impacts of broad scale vegetation changes on flow regime and seasonal flows are highlighted and possible methods of addressing these gaps are suggested.

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# MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

## Impact of Increased Recharge on Groundwater Discharge: Development and Application of a Simplified Function using Catchment Parameters.

**By**

**Mat Gilfedder**
**Chris Smitt**
**Warrick Dawes**
**Cuan Petheram**
**Mirko Stauffacher**
**Glen Walker**

**Technical Report 03/6**

This report describes the development of a simple approach towards estimating the response of groundwater systems to changes in recharge that arise from changes in land-use. The emergent properties of a groundwater system are examined using scaling arguments, by combining the effect of aquifer properties into a single dimensionless groundwater system similarity parameter (G).

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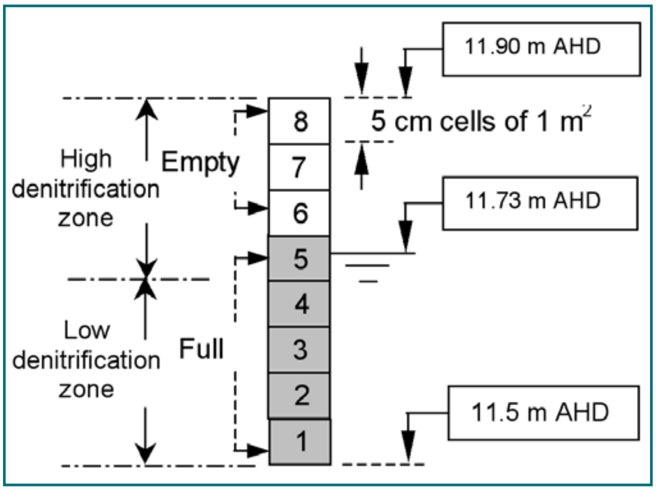


*Figure 2.2: Conceptual bucket model for denitrification*

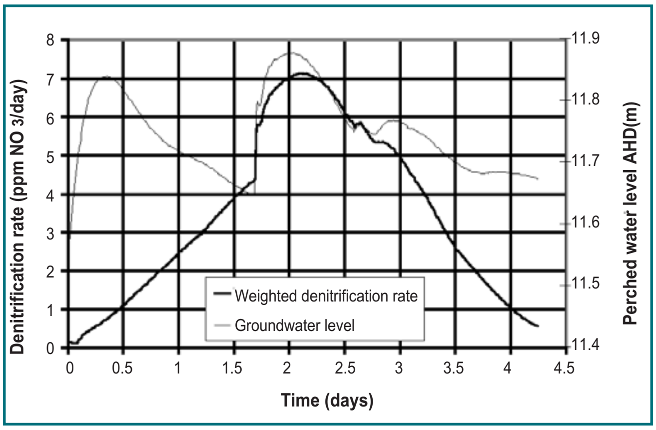


*Figure 2.3: Groundwater levels and weighted denitrification rates*

The model results in Figure 2.4 show the efficiency of nitrate removal down the soil profile. In this example, an initial nitrate concentration of 2 mg/L was assumed. Hence, when a cell fills with water, a total of 40 mg enters that cell (a cell has a pore volume of 20 litres). Figure 2.4 show that cells 1, 2, 3, and 8 fill up once while cells 4, 5, 6, and 7 fill up twice. Cells 4-7 have a total nitrate input of 60 mg (since during re-filling only half of the pore space is assumed to be available). It is demonstrated that cells 1-3 remain full and denitrification has the potential to deplete the nitrate. Cell 4 is located at an elevation that allows it to drain and re-fill again; the inundation period (detention time) is long enough for most of the nitrate mass to be depleted (it is the most efficient cell). Higher up the profile (cells 5-8), the potential for nitrate removal is reduced owing to a shorter detention time.

*Conclusions*

The proposed bucket model provides a simple approach for estimating the potential for denitrification to remove nitrate from groundwater in the perched aquifer system of a small ephemeral stream. The model is based on observed groundwater levels coupled with laboratory measurements of the denitrification potential of riparian soil. The model accounts for a variable detention time and a denitrification rate that varies down the soil profile and with time. Interactions between groundwater hydrology and denitrification rates were found to have a significant impact on potential nitrate removal in the riparian buffer.

*Acknowledgements*

Thanks to Heather Hunter (Project Leader), Christy Fellows, Rob DeHayr, Philip Bloesch, Nerida Beard, Bernie Powell and Stuart Bunn and for their contributions to this research, which is jointly supported by the CRC for Catchment Hydrology and the Coastal CRC.

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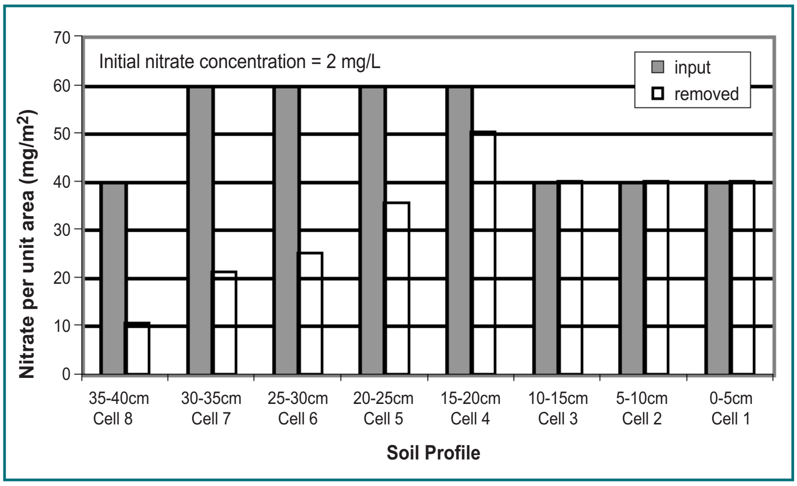


*Figure 2.4: Nitrate input and removal down the soil profile (note that Cell 8 is highest in the profile, see Figure 2).*

PROGRAM 3

**SUSTAINABLE WATER ALLOCATION**

Program Leader
JOHN TISDELL

## Report by Tim Capon

### Risk management of alternative systems of property rights for water resources

*Background*

I started my PhD earlier this year with Dr John Tisdell and Professor Angela Arthington at Griffith University. Previously, I completed my BSc Honours at Griffith in Environmental Policy and Economics. My research project is to investigate the consequences for risk management of alternative systems of property rights for water resources. Because water in Australia is a highly uncertain and valuable commodity, the management of risk and uncertainties associated with water is critical to the future of irrigation and riverine ecosystems. My research project is supported by the CRC for Catchment Hydrology Project 3.09 (3B), which is investigating the economics of permanent water markets. This research also utilises work undertaken in Project 3.08 (3A) by Dr Bofu Yu, who is developing an economic software component for the IQQM catchment model.

*Tradeable property rights*

The promotion of a system of tradeable private property rights for water resources is one major outcome of the Council of Australian Governments (COAG) water reforms. These reforms evolved as a response to a number of prevailing risks and uncertainties. The variability of the Australian climate means that water supplies are inherently uncertain. The cap on water extraction in the Murray-Darling Basin has limited the volumes of water licences at around 1994 levels. Current water policy also recognises the need to maintain environmental flows. So in addition to a variable climate, irrigators are unsure of future environmental water requirements and are concerned about the security of their water entitlements.

Demands for secure private property rights for water is one response to these concerns. Systems of property rights define the rights and responsibilities of property holders and delineate decision-making responsibilities. Property rights also determine who will benefit from production and exchange. Property rights govern who has the responsibility for risk management as well as who will bear the cost of risk. Markets introduce additional mechanisms for risk management but also introduce additional uncertainties about water supply and demand.

*Economic gains from water transfers*

Potential gain from trade in water entitlements is one of the major advantages used to promote tradeable private property rights for water. Economic optimisation models can demonstrate the potential economic gains of water transfers. However, the role of institutions is usually ignored. Assumptions about individual behaviour and decision-making in optimisation models are often violated in observed behaviour, particularly for decisions regarding risk and uncertainty. Alternative systems of property rights and institutions for exchange will ultimately determine whether potential gains from exchange are realised.

*Experimental economics*

As shown in previous *Catchword* articles (e.g. Tisdell, 2003), experimental economics is a methodology that can be used to study the role of property rights and market institutions. Decisions in a variety of economic environments can be studied under laboratory conditions. This method allows the researcher to control the assignment of property rights and design the institutions that govern decision-making. Institutions in experiments determine the types of decisions faced by individuals and the information that is available to them. Using these techniques, policies can be tested before implementation.

Experimental methods are especially useful when economic theory does not provide sufficient detail to predict the consequences of alternative policies. The use of experimental methods in economics ensures that policies are formulated in an operational manner and important details of the economic environment are carefully considered. Importantly, it is the details of institutional arrangements and their consequences for risk management that will determine whether potential gains from trade are realised.

*Risk management*

My research project uses experimental methods to examine the consequences for risk management of establishing tradeable private property rights. Alternative systems of water allocation include volume sharing, capacity sharing and systems of priority allocation, such as high and low security entitlements. Responsibility for risk management is allocated differently under alternative property rights regimes (e.g. Dudley, 1992). For example, if a system of complete private property rights was established for water resources, then all risks would be internalised in the decisions of private irrigators.

*Risk and cost trade-offs*

There are trade-offs, however, between the internalisation of risk and its cost. If risks are shared then

## NEW TECHNICAL REPORT

**Enhancement of the Water Market Reform Process: A Socioeconomic Analysis of Guidelines and Procedures for Trading in Mature Water Markets.**

**By**

**John Tisdell**

**Technical Report 03/10**

This report summarises the main findings of a broad survey of the literature and current government policy on water reform, an extensive survey of irrigator and community attitudes to water reform across the three rural focus catchments of the CRC for Catchment Hydrology and the development and implementation of experimental methods to water management; its auctioning and self governance.

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## MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

### Testing In-Class Variability of Groundwater Systems: Local Upland Systems.

By

Cuan Petheram
Chris Smitt
Glen Walker
Mat Gilfedder

Technical Report 03/8

This report assesses the extent information can be transferred between hydrogeologically similar catchments, by investigating in detail one set of similar catchments.

### Assessment of Salinity Management Options for Kyeamba Creek, New South Wales: Data Analysis and Groundwater Modelling.

By

Richard Cresswell
Warrick Dawes
Greg Summerell
Geoff Beale
Narendra Tuteja
Glen Walker

Technical Report 03/9

This report describes a study of the hydrogeological factors influencing salinity in the Kyeamba catchment, located within the uplands of the Lachlan Fold Belt of south-eastern Australia.

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its cost is reduced. According to the formula used to calculate the cost of risk, the cost of risk rises as the square of the risk so that small changes in risk have a relatively large impact on its cost (Newbery, 1990). This means that if two irrigators are equally risk averse and the risk of water supplies is shared equally between them, then the cost of the risk is halved.

Under a system of volume sharing, in which irrigators share reservoir releases equally, the water authority is responsible for deciding how much water to carry over between irrigation seasons (Dudley, 1988). This system shares risk between irrigators but is unable to take variability in risk preferences between irrigators into account.

*Capacity sharing*

Capacity sharing is the system of property rights designed by Dudley and Musgrave (1988). Capacity sharing defines water entitlements in terms of a share of reservoir capacity, reservoir inflows and outflows. Capacity sharing was specifically formulated so that irrigators could act according to their own risk preferences when managing their water supply. The aim was a system of water entitlements in which individual irrigators are not affected adversely by the decisions of other irrigators (Dudley and Musgrave, 1988). Although the system provides a basis for private property rights, under certain environmental conditions interdependencies between irrigators remain (Dudley, 1992).

*Volume sharing*

Alaouze (1991) compared capacity sharing with volume sharing. Alaouze (1991) showed that the value of expected profits under capacity sharing is at least as high as under volume sharing and water supplies are just as reliable under capacity sharing as under volume sharing.

Dudley (1988) identified communication and coordination problems with systems of volume sharing. For example, it requires a system for communicating probabilities about water supply and demand between reservoir managers and irrigators. Early models of irrigation decision-making are ill suited to analysing such problems as they assumed that a single decision-maker controlled both reservoir and farm management decisions (e.g. Dudley, 1972). However, Dudley and Scott (1993) argued that such models could serve as a standard for comparison with more complex models of decentralised decision-making. In particular, models with multiple decision-makers are needed to study the role of alternative institutions.

*Alternate pricing policies*

Hong and Plott (1982) conducted a study of alternative pricing institutions for the Interstate Commerce Commission in the United States and set the standard for policy evaluation in experimental economics. The consequences of the alternative policies could not be predicted solely from theory, so Hong and Plott (1982) designed experiments to include significant features of the economic environment such as the relative sizes of buyers and sellers and the cyclical nature of demand.

*Murrumbidgee model*

Following this precedent, experiments to evaluate alternative policies incorporate salient features of the economic environment.

To this end, a model of the Murrumbidgee focus catchment has been developed for use in experiments. This is based on a nodal model aggregated by Dr Bofu Yu using the IQQM model of the Murrumbidgee focus catchment. Experimental economic environments can then be designed that capture important features of the economic environment for decisions under risk and uncertainty.

The experimental model represents the crop mix and the relative values of water use at each node. This model is then introduced into the Mwater experiment software developed by Dr John Tisdell so that decision-making can be studied under alternative institutional arrangements and economic scenarios.

*Work ahead*

Experimental methods are well suited to the study of decision-making under uncertainty. Risk is one of the prevailing themes in economics and a method for controlling risk preferences in experiments as first introduced by Roth and Malouf (1979) and extended by Roth *et al.* (1988) as a technique for measuring risk preferences. Such methods can be incorporated in experimental designs to compare the consequences for risk management of alternative property rights regimes. If a private property right allows individuals to make decisions in line with their risk preferences, does it also lead to better economic outcomes? What is the role of the market in risk management?

I look forward to reporting the results of these experiments in future editions of *Catchword*.

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PROGRAM 4

## URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

**Report by Tony Ladson, Chris Walsh, Tim Fletcher, Scott Cornish**

### Beyond the 10% rule: Improving streams by retro-fitting in suburbs to decrease the connections between impervious surfaces and waterways

*Urban development and degraded streams*

Many urban streams are unhealthy; the challenge is to determine the cause and implement a solution. One idea, championed by the Pew Oceans Commission in the US is the so called 10% rule (Beach, 2003). Where more than 10% of a catchment consists of impervious surfaces, the biological condition of a stream is likely to be degraded because of increased flows, higher temperatures and poor water quality. Therefore, according to Beach (2003) it would be best to concentrate urban development in areas that have already passed the 10% threshold and protect remaining undeveloped catchments that surround our cities.

*Beyond the 10% rule*

Our research is aiming to go beyond the simple prescription of a 10% rule and offer strategies to improve the health of streams in urban areas that are already developed. Recent work has shown that stream health is strongly influenced by the proportion of a catchment that consists of impervious surfaces directly connected to waterways. The direct delivery of water and pollutants from impervious surfaces to streams has a major detrimental effect on stream health. Where there is opportunity for attenuation of these inputs, that is, where the link between impervious surfaces and streams is less direct, the damage to stream health seems to be mitigated. This suggests that improving stream health, in areas subject to urbanisation, in part, involves finding ways to decrease the efficiency of water delivery from impervious surfaces. In other words, it is not the total amount of impervious surface in a catchment which causes stream degradation, rather it is the proportion of catchment imperviousness that is directly connected to waterways.

We are now investigating the feasibility of approaches that could be used to retro-fit an existing suburb to improve stream health by decreasing the connection between impervious surfaces and waterways. Possible approaches include: rainwater tanks, rainsaver systems,

## NEW TECHNICAL REPORT

### Non-Structural Stormwater Quality Best Management Practices - Guidelines for Monitoring and Evaluation

**By**

**André Taylor**
**Tony Wong**

**Technical Report 03/14**

This report presents a new evaluation framework and guidance for measuring the effects and life-cycle costs of non-structural BMPs. This framework defines seven different styles of evaluation to suit the needs and budgets of a variety of stakeholders involved with stormwater management.

**Printed and 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 available as an Adobe .pdf file.**

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# URBAN STORMWATER SOFTWARE

## Model for Urban Stormwater Improvement Conceptualisation (MUSIC)

**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 is available from the Centre Office for $88.00**

**Individuals will need to sign a Licence Agreement (available from the Centre Office and website: www.catchment.crc.org.au)**

**For further information contact the Centre Office on 03 9905 2704 or email crcch@eng.monash.edu.au**

**Please note: MUSIC version 1.00 is a development version and will be valid until December 2003. The CRC for Catchment Hydrology is committed to updating MUSIC annually until at least 2006. Subsequent versions of MUSIC may be charged for.**

grassed swales, porous pavements, infiltration pits and trenches and ponds and wetlands.

*Candidate urban areas*

We are concentrating our work on Melbourne's suburbs where streams are in moderately degraded ecological condition even though development is concentrated in a small part of their catchments and the proportion of imperviousness is quite low. Typically these are areas where the proportion of connected impervious surface is high. These suburbs are good candidates for intervention because a relatively small change in the amount of connected impervious surface could tip them from being unhealthy back to being healthy. The first sites for investigation are in the catchments of Dobsons Creek and Little Stringbark Creek that drain the Dandenong Range in Melbourne's east.

*Linking ecological health and connected impervious area*

Our measurement of health is based on macroinvertebrate taxa as represented by a scoring system for water bugs, the SIGNAL score (Chessman 2003). Chris Walsh, from the Cooperative Research Centre for Freshwater Ecology, has developed a model for the east of Melbourne that predicts improvement in SIGNAL score from changes in connected impervious area. Using this model we can work out in advance the amount of change required and then investigate strategies to achieve the reduction in connection.

*Options to decrease connected impervious area*

One promising approach is to decrease connected impervious area through the use of rainwater tanks. Roofs represent a large proportion of the impervious surface in urban catchments and installing rain water tanks can decrease the amount of connection between these surfaces and streams. Rainwater tanks also offer benefits of reduced requirements for mains supply, savings in stormwater infrastructure because of reduced peak runoff rates, and decreased pollutant loads to waterways. However rain tanks will not provide the whole solution to achieving waterway health as the water coming from roofs is of relatively good quality. So although installing tanks can decrease pollution loads to streams, concentrations can increase.

The limited benefits of rain tanks mean that strategies for decreasing the connection of roads and car parks, to streams, are also important. Permeable pavements are one option. In most cases it won't be feasible to replace existing paved areas, that are in good condition, with permeable pavements, but a long term strategy of using permeable pavements for new or maintenance work will gradually decrease connected impervious area. It's also important not to forget driveways and parking areas on private property. Runoff from these areas often flows directly to streams, via the stormwater system, so there will be benefits from using permeable pavements instead of standard approaches. Perhaps there could be an incentive program to encourage people to implement environmentally sensitive driveways? Where it is not feasible to change the type of pavement, there is strong evidence that draining roads and car parks to streams via grassed swales will also decrease connection and improve stream health.

Data collected by the CRC for Freshwater Ecology suggests that draining stormwater via a system of curb and channel is much worse for streams than even informal earthen and grass channels that traditionally would have been seen as a second class option for managing road side drainage.

*Summary*

In summary, we are investigating a range of measures to decrease connection between impervious surfaces and streams and are aiming to predict their effect on stream health as measured by indicators based on macroinvertebrate populations. We are also planning to work with local government and the community to develop demonstration sites to showcase the most promising approaches and test their effectiveness.

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PROGRAM 5

**CLIMATE VARIABILITY**

Program Leader FRANCIS CHIEW

## Report by Harald Richter

### Irrigation impact in Numerical Weather Prediction Models

*Introduction*

The best available tool for the deterministic prediction of Australia-wide rainfall in the 6-hour to 5-day range is almost certainly a numerical weather prediction (NWP) model. The effort needed to arrive at a single such rainfall prediction is significant as thousands of surface station, satellite, ship, buoy, aircraft and miscellaneous other observations over Australia and beyond need to be ingested into a complex and lengthy computer code which has been developed over the past three decades.

*Rainfall and irrigation*

Rainfall is one of the most challenging output fields to model correctly as it marks the "end of the food chain," i.e. all other model fields such as temperature, humidity or wind need to be modelled correctly before an accurate rainfall prediction can be produced. One physical element that contributes to the spatial and temporal distribution of rainfall is that fraction of the total land surface water that is available for evapotranspiration. In some regions of Australia this quantity has been anthropogenically altered by irrigation practices.

Past observational (Barnston and Schickedanz 1984; Moore and Rojstaczer 2001) and numerical modelling studies (Adegoke *et al.* 2003; Segal *et al.* 1989) present a wide range of potential impacts of irrigation on rainfall. For example, while Barnston and Schickedanz (1984) found a 25% increase in regional precipitation associated with irrigation in the Texas Panhandle, Moore and Rojstaczer (2001) question the very existence of an appreciable irrigation effect on rainfall. Fundamental methodological difficulties prevent the establishment of any clear relationship between irrigation and rainfall. In observational studies it is nearly impossible to separate the effect of irrigation on rainfall from concurrent land-use change and climate variability signals. In numerical modelling studies the sensitivity of the various parameterisation schemes to prescribed moisture strongly interferes with what is likely to be a fairly subtle signal.

*Incorporating irrigation*

In Project 5.05(5A) we have launched an effort to explore the effects of irrigation in the Australian Limited-Area Prediction System (LAPS). The intent is to ultimately incorporate the effects of irrigation into the operational Australian NWP models to arrive at an improved rainfall prediction. We follow a standard two-step method: (1) the exploration of LAPS' sensitivity to an idealised irrigation patch and (2) an evaluation of whether the inclusion of irrigation into LAPS leads to better predictive skill.

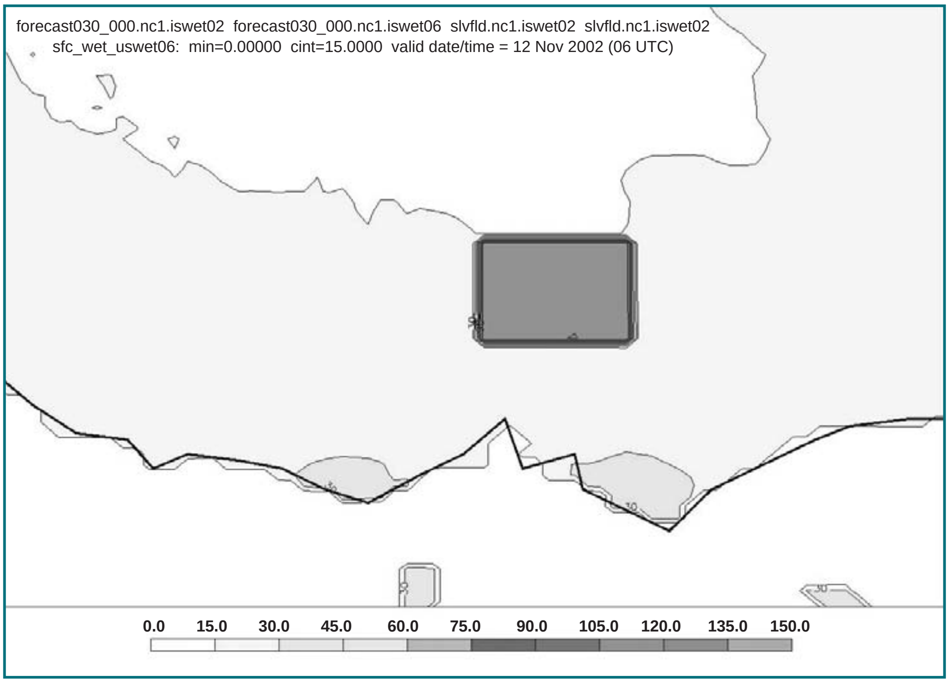


*Figure 5.1. Soil wetness values (mm) over Victoria in the IRR run for the case of 12 November 2002 (06 UTC). Generally low (< 30 mm) soil wetness values are evident, except in the idealised irrigated region where values are set to 130 mm at the NWP model initialisation.*

## NEW TECHNICAL REPORT

### Stochastic Generation of Climate Data

By

Ratnasingham Srikanthan
Senlin Zhou

**Technical Report 03/12**

This report describes stochastic climate data generation models for the generation of annual, monthly and daily climate data (rainfall, potential evapotranspiration, maximum temperature and other variables) that preserves the correlation between the different variables. The performance of the models are evaluated using climate data from ten sites located in various parts of Australia.

**Printed and 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 available as an Adobe .pdf file.**

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# NEW TECHNICAL REPORT

## Predicting the Effects of Large Scale Afforestation on Annual Flow Regime and Water Allocation: An Example for the Goulburn Broken Catchments.

By
Lu Zhang
Trevor Dowling
Mark Hocking
Jim Morris
Geoff Adams
Klaus Hickel
Alice Best
Rob Vertessy

**Technical Report 03/5**

This report bridges part of the gap between the science of catchment water balances and the management of catchments.The language has moved from "annual average yield " to "water security". Afforestation and water remains a contentious issue. This report sets out an important case study to underpin future decision-making.

**Printed and 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**

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*Methodology*

A rectangular "wet patch" with dimensions 67 km x 89 km is prescribed in north central Victoria, broadly in agreement with the real irrigated area. Within this patch the initial soil water content in the model is set to 86% of field capacity (Fig. 5.1). This idealised irrigation patch is suitable for showing the impact of irrigation on the NWP model output. The intention of this first step is not (yet) the realistic incorporation of irrigation into the model, because such a procedure would unnecessarily complicate the interpretation of the model response to irrigation. About twenty NWP twin-forecasts out to 36 hours were run for randomly chosen dates during the 2001/2002 and 2002/2003 irrigation season. The control run (CTRL) closely resembles the standard operational NWP model run, while the irrigation run (IRR) includes the "wet patch" outlined above.

*Effect of irrigation on the model fields*

Figure 5.2 illustrates the effect of the irrigation patch on:

(a) humidity

(b) temperature

(c) wind

(d) rainfall field

in the model for a 30-hour forecast valid on 12 November 2002 (06 UTC; or 12 November 2002 4 pm LST). At this time a model surface cold front (not shown) was draped across western Victoria with a northwest to southeast orientation. Ahead of this front, northerly to northwesterly flow was carrying evaporatively cooled and moistened air from the irrigated patch off to the south and southeast (Fig 5.2 a,b). Regions within this moist cool plume also exhibit a significant change in wind speed with the addition of a generally easterly component to the surface flow (Fig. 5.2c). The result is a slower movement of the cold front and its associated frontal precipitation band in the IRR run evident in Fig. 5.2d. Fig 5.2d therefore shows how a localised irrigation patch can affect rainfall in a non-local manner by influencing the regional circulation in the atmosphere.

*Does the inclusion of irrigation improve the NWP model?*

A more difficult step is to ascertain whether the inclusion of irrigation information improves the overall skill of the LAPS NWP model. The complexity of interacting nonlinear processes in the model (as represented by various LAPS parameterisation schemes) means that a more realistic representation of soil moisture in the model is linked to the overall model skill in an equally complex manner. A preliminary evaluation of model rainfall against raingauge observations using RAINVAL (see Beth Ebert's article in *Catchword* Issue 94) shows only minor differences between the CTRL and IRR rain fields with no clear evidence of which model performs better. Work regarding this evaluation is in its early stages. For this second stage we require, for example,

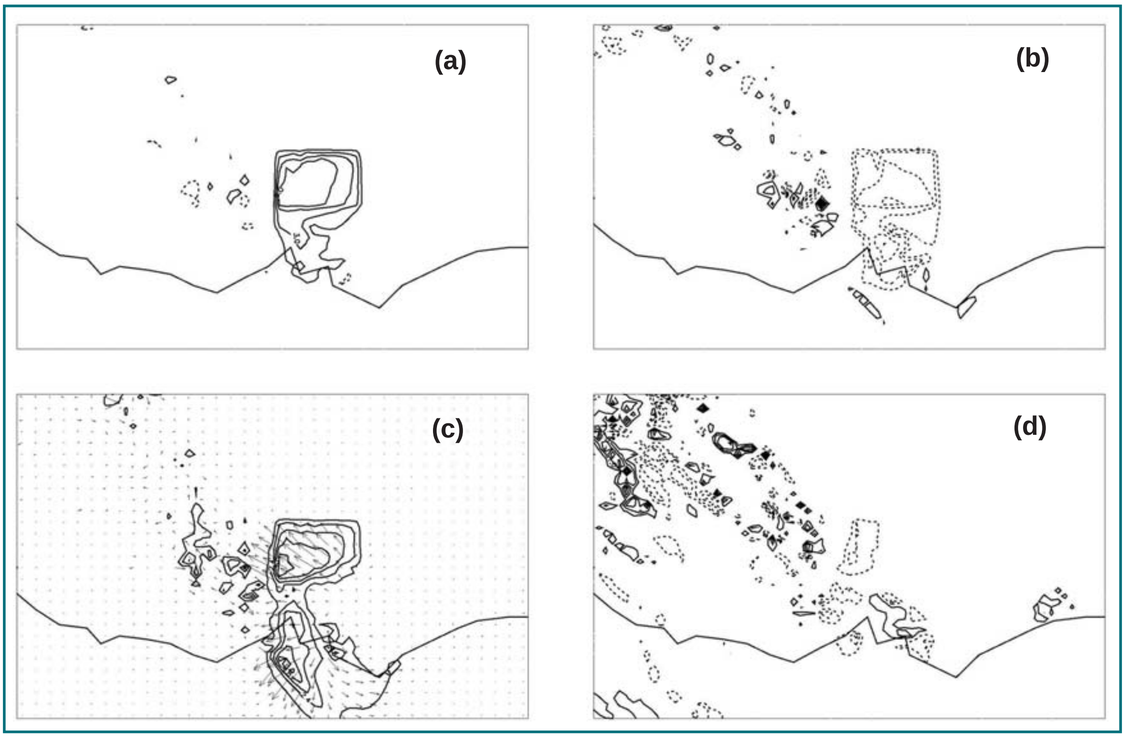


*Figure 5.2. Difference fields between the IRR and CTRL run for the 12 November 2002 (06 UTC) case. Shown are differences in the (a) mixing ratio (g kg$^{-1}$), (b) air temperature (°C), (c) horizontal wind speed (m s$^{-1}$) and (d) rainfall (mm). Positive contours are solid, negative ones dashed. The contour intervals are (a) 1.5 g kg$^{-1}$, (b) 1 oC, (c) 1.2 m s$^{-1}$ and (d) 0.5 mm.*

a more realistic specification of the spatial and temporal characteristics of the irrigation-related water supply to the atmosphere.

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PROGRAM 6

## RIVER RESTORATION

Program Leader
MIKE STEWARDSON

### Report by Bob Keller

### Minimum energy loss design and the MELS program

*Culvert and bridge crossings – impact of energy losses*
The design of conventional culverts and bridge crossings pays scant attention to efficient hydraulic principles. As a result, such designs are frequently accompanied by significant energy losses due to flow separation, high turbulence (and consequent erosion), and the formation of hydraulic jumps. Significant increases in upstream water levels, and consequent increases in flood intensity and duration, are the inevitable consequences.

*Research on minimum energy losses*
Over the last few years, Lucia Cade and Frank Winston have undertaken research at Monash University - under an associated project of the CRC for Catchment Hydrology, funded by VicRoads and the NSW Roads and Traffic Authority – to develop a computer program for the design of minimum energy loss bridge crossings. This project is now nearing completion.

The technique of minimum energy loss design involves the design of a culvert or bridge waterway such that the flow in the upstream approach channel is contracted over the length of an inlet fan into the throat or barrel before expanding in a streamlined outlet fan to eventual release into the downstream channel. The designed structure includes the inlet and outlet fans as well as the barrel section.

*Design strategy for energy losses*
The over-riding consideration in the design strategy is that energy losses are kept as small as is possible. In the inlet and outlet fans, this is achieved by careful shaping to ensure that there is no significant form loss. The net result is that the energy loss through the engineered structure may be equal to or even less than the energy loss in the original natural stream. In the latter situation the structure may even have a beneficial effect on flood levels upstream.

A mathematical model of the path formed by a naturally meandering river is used to design the shape of the walls directing the contraction and expansion of the flood flow. Since the natural course followed by a hydraulically stable river represents the course of minimum stream power expended it follows that the use

## WEATHER RADAR CONFERENCE

### Sixth International Symposium on Hydrological Applications of Weather Radar

**2-4 February 2004**
**Melbourne, Australia**

The major theme of this conference is 'The successful implementation of radar technology for hydrological and quantitative rainfall applications'.

**For more information on the symposium, please visit www.bom.gov.au/announcements/conferences/hawr2004 or email hawr2004@bom.gov.au**

**The conference is supported by the Commonwealth Bureau of Meteorology, the CRC for Catchment Hydrology and the Australia Meteorological and Oceanographical Society**

# NEW SOFTWARE - CHUTE

## www.toolkit.net.au/chute

CHUTE carries out the hydraulic design of rock chutes for stabilising channel beds and is designed for use by professional engineers and managers involved in stream rehabilitation and restoration.

CHUTE is the first of many products that will be available to the land and water industry via the Catchment Modelling Toolkit website at www.toolkit.net.au

Members of the toolkit website can download the CHUTE software by visiting www.toolkit.net.au/chute and logging in.

**For further information including copies of the Rock Chute Design Guidelines, please visit www.toolkit.net.au/chute**

of a natural meander model to train the direction of flow in the fans is energy efficient.

*Minimising width of structures*

Concurrent with a minimisation of energy loss, it is often desirable to minimise the width of the structure barrel to reduce costs. This may be achieved by depressing the invert of the structure. However, depressing the invert of the structure leads to the likelihood of sediment deposition during periods of low flow. It is, therefore, a feature of properly designed minimum energy loss structures that accumulated sediment is swept out of the barrel during large flow events.

*Design procedure and software*

A major focus in the development and presentation of the design procedure and software has been to make them as user-friendly as possible. The software has been written as an Excel Workbook with separate spreadsheets for site-specific and flow input parameters, structure design, structure performance, and sediment sweep-out.

The purpose of the performance and sweep-out modules is to check the designed structure under conditions of off-design flows and/or sediment retention. The modules use a "quasi-steady" flow computation routine to model the flow behaviour through the structure. Program options allow a full range of theoretical performance tests to be made. Single runs can be performed to check water surface profiles at the design flow or at any other flow rate. Alternatively, a hydrograph input can be specified to model performance over the entire expected range of operation. Roughness values for the fans or barrel can be altered to assess their effect on performance. In addition, the user may specify a level of sediment retained in the structure up to a maximum of the level of the outlet lip. The program will continue to run until all of the sediment has been swept from the structure. A report of the sweep-out time is given as well as a record of water level as a function of time during the run. The sediment sweep-out tests can be run with or without an input flow of sediment at the upstream boundary.

*Predictive capabilities*

These facilities greatly enhance the predictive capabilities of the design procedure. Because of the large range of possible flow scenarios, including subcritical, supercritical, and mixed regime, the mathematical and numerical procedures are complex. Full details of these aspects are given in the Guidelines.

*Cost savings with minimum energy loss*

A comparison between minimum energy loss (MEL) design and conventional design shows that cost savings of up to about 33 % are possible, depending on site conditions. However, MEL structures incorporate associated inlet and outlet fans which require a greater length of waterway to be available for the structure than would be necessary for a conventional structure.

The program MELS and accompanying Design Guidelines will be released as a Toolkit product at the Catchment Modelling School in February 2004.

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## COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

**Report by Susan Daly**

**The Flow on Effect December 2003**

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

**Early next year, the CRC for Catchment Hydrolody web site will undergo a transformation. The user interface will be one of the most critical elements in the re-design. What comprises a good user interface and why is it so important ?**

*Introduction*

I'm sure most *Catchword* readers are familiar with the CRC for Catchment Hydrology web site. This web site will undergo a change in the coming months, both visually and structurally. A new user interface will be a vital element in our re-design and in this article I will address what it is, why it's important, and the methodology we'll use in re-designing it.

*What is a User Interface?*

The term User Interface generally refers to those related to computers, which is the context in which I will talk about here, but this is only one example. In fact, any machine that requires interaction with human beings has some sort of user interface, for example your microwave, your mobile phone or your car. User interfaces can take on many forms but always accomplish two fundamental tasks: communicating information from the machine to the user, and communicating information from the user to the machine.

*The history of User Interfaces*

User Interfaces haven't always been graphical like most we see today. Users used to communicate to computers by typing in commands that were generally tailored more to the computers than the users. User interfaces entered the modern era when designers at the Xerox Research Center broke away from the character-based interface paradigm and invented the Graphic User Interface (GUI). In this way the interface was focused on the needs of the human beings, rather than the other way around.

*Why is User Interface Design important?*

How the user experiences the end product, is the key to acceptance. And that is where User Interface Design enters the design process.

The importance of good User Interface Design can be the difference between product acceptance and rejection in the marketplace. If end-users feel it is not easy to learn, not easy to use, or too cumbersome, an otherwise excellent product could fail. Good User Interface Design can make a product, or web site easy to understand and use, which results in greater user acceptance.

*Creating a better User Interface for the CRC web site*

Our methodology will incorporate these main steps:

- Determine who our users are and their needs
- Analyse the current site to identify existing problems and areas that work well
- Prototyping and Usability Testing
- Incorporation of basic design principles

*Better for Whom? Determine needs*

Before we can answer the question "How do we create a better user interface", we must first answer the question: Better for whom? A design that is better for one user may not work for another.

One solution is to create "user profiles". The result of this process is a detailed description of one or more "average" users, with specific details such as:

- What are the user's goals?
- What are the user's skills and experience?
- What are the user's needs?

As a method of gathering this information we'll talk to some real users. Direct contact between end-users and developers has often radically transformed the development process.

*Identify existing usability problems*

It's important to find out which areas of the current site users are having problems with and which areas work. Here are a couple of different techniques we'll use:

- Analyse email feedback about the existing site
- Online surveys of user groups
- Usability Testing on the exiting site

*Prototyping and Usability Testing*

It is important that Prototyping and Usability Testing are carried out from the beginning of the project. We'll start off creating an interface flow diagram before building a prototype that shows screens without the data. This will then be presented to potential users. As they navigate around the web site we'll ask them to verbalise/document their thought process. The next step is to evaluate the prototype: what's good, what's bad, what's missing. After this we may find we need to scrap

## CATCHMENT MODELLING SCHOOL 9-20 February 2004 LAST DAYS TO REGISTER

The CRC for Catchment Hydrology is presenting an impressive range of modelling software workshops over a 2 week period as part of the Catchment Modelling School from 9 February 2004. Registrations close soon so secure your place now.

**To find out more information about the Workshops and Register your place, visit www.toolkit.net.au/school**

## HYDROLOGY AND FLUVIAL GEOMORPHOLOGY WORKSHOP - Information now available

The Hydrology and Fluvial Geomorphology Workshop is offered by The University of Melbourne as part of the Catchment Modelling School during 9-20 February 2004. Information and a downloadable PDF brochure is now available from the Catchment Modelling School web site. Go to www.toolkit.net.au/school and click 'Workshop Details'.

To participate in any of the individual days offered by this Workshop, please fill out the registration form on the last page of the brochure, select the day/s you would like to attend and fax or mail to the CRC Centre Office.

**Registrations for the School close on Friday 19 December 2003.**

**www.toolkit.net.au/school**

## MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

### Modelling the Effectiveness of Recharge Reduction for Salinity Management: Sensitivity to Catchment Characteristics.

By
Chris Smitt
Mat Gilfedder
Warrick Dawes
Cuan Petheram
Glen Walker

**Technical Report 03/7**

This report describes the use of modelling to investigate the sensitivity of groundwater and other characteristics on the effect of recharge reduction on salinity management.

**This report is available as an Adobe .pdf file only.**

**Visit www.catchment.crc.org.au/publications and search under 'Land-use Impacts on Rivers'**

parts, modify parts, and even add brand-new parts. We'll continue the evolution of the prototype using this process until the final version of the site is created.

*Using basic Design Principles*

There are a number of basic design principles that we'll follow in order to deliver an effective interface design, namely:

- Simplicity: keep it simple and straightforward. A poorly organised and cluttered interface distracts users from accomplishing their everyday tasks.
- Consistency: look and feel needs to be consistent to maintain branding and the same method of navigation needs to be repeated throughout.
- Familiarity: Build on prior knowledge. The use of concepts and techniques that users already understand from their real world experiences allows them to get started and make progress quickly.
- Make things comprehensible: Basic controls should immediately be apparent and their functions identifiable.
- Support different user levels: Support all users from novices to experts.

As users of the CRC web site, your feedback is vital – so stay tuned for your invitation to become involved in this project. With careful planning, testing and design methodologies, we hope this project will enhance the user experience of the CRC web site and provide users with the information they need quickly and easily.

*References:*

IBM 'Ease of Use' design guidelines - http://www-3.ibm.com/ibm/easy

Usernomics: UI design & Usability Testing – http://www.usernomics.com/user-interface-design.html

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# POSTGRADUATES AND THEIR PROJECTS

## Elisa Howes

I've always had a certain sensitivity for all living things, and from a young age it was evident that my future lay in the field of environmental studies. My mum can confirm this, having seen me (a shy non-violent 8 year old) punch the boy next door for tearing a branch off our lemon tree. In fact my general response to the "what do you want to do when you grow up?" question was always a very humble "save the world."

In my pursuit to do just that, I completed a degree in Environmental Engineering (Hons) (because Engineers do the real problem solving of course!), coupled with a Bachelor of Science (Earth Science – Meteorology major), at Melbourne University. Three years into my course I attained 3 months vacation work (2000/2001) with the CRC for Catchment Hydrology, consisting of a summer doing river surveying, data entry, negotiating blackberries, and overall getting valuable field work experience. My love of the river was founded. In the following year I used this data for my final-year research project in engineering, where I investigated the validity of using a 'representative reach' to infer results about a larger segment of river. This initiated my interest in a range of spatial issues relevant to observing and sampling stream characteristics, and before I realised it, I had…'specialised.' No more landfill, soil contamination, or sewage treatment for me, the world of rivers had claimed another engineer. So much so that upon finishing my undergraduate studies last year I decided to pursue postgraduate study in this field.

The question of scale is a serious issue for river research, particularly when trying to quantify the variability and dynamic nature of stream systems. Frissell *et al* (1986: p199) pinpoint three challenges central to achieving advances in river research and management:

1) How do we select representative or comparable sites in such diverse environments?

2) How can we interpret in a broader context, or how far can we reasonably extrapolate, information gathered at specific sites?

3) How do we assess past and present possible future states of a stream?

To address these questions Frissell *et al* (1986) proposed a hierarchical framework for stream habitat classification, employing a range of conceptual spatial scales (e.g. catchment, segment, reach, pool/riffle, and patch) to aid understanding of variability within and among streams systems. To date, a considerable number of iterations have been proposed, all employing similar conceptual spatial scales. However despite the wide acceptance of viewing stream systems in this context, there remains a considerable lack of quantifiable evidence to support such a view. Essentially, it should be determined if there is a quantifiable reason for 'zooming in' on the catchment at these common conceptual scales. My work will involve examining these scales to determine if they are spatially distinct in terms of physical habitat variability (in-stream habitat units and parameters), and hence if such a view of the catchment assists in answering the long standing questions posed above.

I anticipate that a large portion of my data will be collected by myself and any willing (or possibly un-willing) assistants, and I'm looking forward to getting back into the streams. Catchment-wide data collection is likely to prove challenging… however I have a vision of a kayak, a wetsuit, and water-proof logbooks (!).

I'm really enjoying my research; the field of habitat-hydraulics has definitely captured my interest. I propose that ultimately, to advance our understanding of stream processes such as interactions between flow, habitat and ecology, and to make predictions catchment wide, managers and researchers need a quantified spatial framework to operate within. All going well, I hope to deliver that!

*Reference:*

Frissell, C.A., Liss, W.J., Warren, C.E., and Hurley, M.D. (1986). A hierarchical framework for stream habitat classification: Viewing streams in a watershed context. *Environmental Management* 10(2): p. 199-214.

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# MUSIC TRAINING - REGISTER NOW

As part of the Catchment Modelling School planned for 9-20 February 2004, a two day basic and a one day advanced MUSIC training workshop is being offered to MUSIC users.

The Catchment Modelling School will be held at The University of Melbourne and participants can select from a range of over 40 different workshops. For more information about the Catchment Modelling School or to register to attend either of the MUSIC workshops, please visit www.toolkit.net.au/school

NOTE: There are limited places at these workshops, so be sure to register soon to avoid disappointment.

www.toolkit.net.au/school

## www.toolkit.net.au

The Catchment Modelling Toolkit web site continues to expand. The Toolkit web site will be used to deliver the CRC for Catchment Hydrology's modelling software and supporting documentation over the next three years.

Members of the Toolkit web site can now download the River Analysis Package (RAP) and the Rainfall Runoff Library (RRL) by logging in and visiting:
www.toolkit.net.au/rap
www.toolkit.net.au/rrl

More software products will be available to download from the Toolkit site over the coming months, so keep an eye on www.toolkit.net.au

**For further information visit www.toolkit.net.au**

**Comments and queries can be directed to**
**David Perry**
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# CRC PROFILE

## Our CRC Profile for December is:

### David Wotton

Having now been 'retired' from politics for some eighteen months it is interesting to reflect on some twenty-seven years in public life and the important part that water has played during that time. I was elected the Member for Heysen in the South Australian Legislative Assembly in 1975. The electorate of Heysen, which takes its name, of course, from Sir Hans Heysen, the famous Australian artist, is a semi-rural electorate in the Adelaide Hills within the Mt. Lofty Ranges.

It is something of an understatement to say that water and its availability has always been a critical issue in South Australia. The city of Adelaide depends on two sources of water - the River Murray and the Mount Lofty Ranges Catchment. The electorate of Heysen, being situated in the centre of this largely developed catchment, has meant that the conservation and protection of this vitally important source, water, has always been and will continue to be a critical issue.

Most of the twenty-seven years of my political career has been spent on the front bench, with responsibility for the Environment portfolio, either in Government or in Opposition. This has meant that I have had a significant involvement in water related issues which have provided me with the opportunity to play an important role in policy direction and implementation relating to water management.

My first term in Government as Minister for Environment and Planning between 1979 and 1982 saw the Environment and Water Resources portfolios become much more inter-woven.

On coming to office again in 1993 as Minister for Environment and Natural Resources, including water resources, I asked the SA Water Resources Council to provide recommendations on water planning as part of the Government's commitment to developing a South Australian Water Plan. The plan, 'South Australia – our water, our future', was released in 1995 and included a statement of the Government's policy on managing the water resources of the state so that its rivers, streams and groundwater aquifers could be developed in an ecologically sustainable manner.

In that same year, I introduced the South Australian Catchment Water Management Bill which provided for the establishment of catchment boards with the aim of harnessing the energy of the community, the expertise of Councils, and the legislative backing of the Government to clean up our waterways and develop stormwater as a resource. This legislation provided for the effective devolution of much of the authority for water resource management to catchment communities, and brought with it the creation of a supporting levy which remains in place within the catchments throughout much of the State.

Without doubt the River Murray is the most important natural resource in SA. Its economic, social and environmental values affect the lives and well being of every South Australian. I was fortunate to be the lead Minister for SA on the Murray-Darling Ministerial Council between 1993 and 1997. During this period the Council confirmed a permanent Cap on all diversions from the Basin's rivers effective from July 1997, an essential first step in providing for the environmental sustainability of the river system of the basin. The Ministerial Council also introduced a pilot project to allow permanent interstate water trade. Both of these initiatives were significant achievements in assisting with the management of the Murray system.

Further to the passing of a resolution in State Parliament moved by the current Minister for Environment, the Hon John Hill MP, I was elected, in 2000, while Deputy Speaker and Chairman of Committees, to Chair a Select Committee of the SA Assembly on the Murray River. Through this Select Committee the SA Parliament successfully managed to bring together members from various political persuasions so enabling the Committee to bring down a consensus report that outlined a direction for the future use and management of the River Murray in SA. I am pleased to say that a significant number of the 96 recommendations contained in that report have been, or are in the process of being, implemented.

On leaving Parliament in 2002, I was appointed Presiding Member of the River Murray Catchment Water Management Board in SA. Working in partnership with the total catchment community and stakeholders, the Board's objective is to achieve a sustainable balance between the economic, environmental and social needs of the catchment and its communities. One of the Board's major responsibilities is the implementation of the RMCW Management Plan and Water Allocation Plans for prescribed water resources. These Plans identify key strategies that ensure the long - term future of the Murray River in SA.

I was fortunate to have been appointed the CRC for Catchment Hydrology Visitor in April of this year. My other current responsibilities include; Chair of the SA Local Government Association Waste Management Committee and Chair of Adelaide Hills Tourism.

Most importantly, I am married to Jill and we have four adult children all living in South Australia.

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# WHERE ARE THEY NOW?

## Report by DD Kandel

### Hanging around in Melbourne!

I submitted my thesis in September this year and am still hanging around in Melbourne. For those readers who are not aware of my PhD work, the title of my thesis is "Representation of short time-scale processes in daily time-step surface runoff and erosion modelling." My thesis addresses the temporal scaling issues associated with processes controlling surface runoff generation and erosion, which are highly nonlinear. Their behaviour is determined mostly by short time-scale peak intensities of rainfall (kinetic energy) and the associated runoff, but owing mainly to the lack of adequate data support at this scale they are often modelled using coarse time-scale data (usually daily). It is generally recognised that this scale mismatch can be problematic for these non-linear processes, hence the scaling becomes a fundamentally important issue in hydrologic and erosion modelling.

My thesis evaluated a range of approaches to temporal scaling and focussed on development of a distribution function approach that was both parsimonious and accurate when applied to field data from Nepal and Australia. This study illustrates that rainfall scaling is a useful tool in temporal scaling of hydrologic and erosion processes, particularly where continuous simulation is preferred, and that the distribution function approach is promising as a general temporal scaling tool. A more detailed description of this study can be found in an earlier issue of *Catchword* (No 117, June 2003).

I am currently eagerly waiting the examiners' comments on my thesis, and while doing this, am working with Dr Jeffrey Walker (Senior Lecturer in Environmental Engineering at the University of Melbourne) on a project entitled "Optimal land initialisation for seasonal climate prediction: brightness temperature assimilation." This project is investigating the assimilation of brightness temperature measurements from a passive microwave radiometer on board a remote sensing satellite. Such measurements contain soil moisture and temperature information that can be used to correct land surface model predictions of those states, and ultimately improve flux predictions back to the atmosphere. This research supports the retrieval of continental-scale land surface initial conditions (soil moisture and temperature) required for making seasonal climate predictions with a global climate model. Such initial conditions will be used by the NASA Seasonal-to-Interannual Prediction Project.

Although this work is not directly related to my PhD, it has provided me an opportunity to work in a different modelling environment at large spatial scales (continental in this case). The work is interesting and involves programming and model development, in addition to running simulations of Australian soil moisture content and undertaking analysis.

I hope to complete this work by the end of February 2004. Then, you may still find me hanging around in Melbourne, as I have no plans to return to Nepal, at least for sometime, under the circumstances (i.e. unfavourable working environment due to the Maoist insurgency)!!

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## CRC PUBLICATIONS LIST

A complete list of all documents and products produced by the CRC since 1993 is available at our web site at 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 and Mines, Qld
Southern Rural Water
The University of Melbourne
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**Associates:**
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**Research Affiliates:**
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National Institute of Water and Atmospheric Research, New Zealand
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