NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

# CATCHWORD

NO 110 OCTOBER 2002

## A NOTE FROM THE DIRECTOR

**Professor**
**Rob Vertessy**

**Inside...**



## OUR ROLE IN AUSTRALIAN NATURAL RESOURCE MANAGEMENT

It's healthy to ask and re-ask ourselves who we are and where we fit in the world. In this issue of *Catchword* I'd like to address these questions.

Like most economically-developed nations, Australia now has a burgeoning Natural Resource Management (NRM) sector dealing with land and water management problems. It is grappling with the legacy of exploitive land and water utilisation over two centuries of European settlement, compounded by our highly variable climate and the cruel sequences of floods and droughts that we endure. The legacy of this includes salinised, acidified and eroded land, polluted aquifers, waterways and receiving waters and the poor biodiversity within them. We have also been left with degraded riverine and riparian habitats, river instability, and an inequitable distribution of water amongst different users and the environment. Some of these problems are more pervasive than others. Whilst some of them are undoubtedly worsening it is true to say that our standards are increasing rapidly, making them much more of an issue. As a society, we are becoming more appreciative of the problems and formulating visions of how we want the landscape to look. The recent upswing in community and government dialogue on the environmental flows issue is a good case in point.

Over the last decade and a half we have witnessed several major NRM initiatives such as Landcare, the Natural Heritage Trust, the National Land and Water Resources Audit, the cap on flow diversions and the advent of water trading in the Murray-Darling Basin, and the National Action Plan on Salinity and Water Quality. Incrementally, the NRM sector is becoming a more significant component of our societal fabric, evidenced by the growing popularity of the triple-bottom-line concept. As the NRM sector becomes more sophisticated, there is a growing demand for analytical tools to underpin integrated catchment management plans. However, catchment management is no longer something done by technocrats alone. It is all about governments (of various levels) working with communities and industries to balance the many competing needs we have for catchment services. Hence, the tools being sought have to be utilitarian in terms of their analytical or predictive capacity, and sufficiently transparent that the broad-based catchment management constituency can relate to them.

Our CRC has a small but important role to play in servicing this need. Our role is well summarised by our Mission Statement:

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

This is complemented by our Vision Statement:
'Sustainable management of the nation's water resources through adoption of an integrated approach to land-use, water allocation, hydrologic risk, and environmental values'.

Hence, our research portfolio is very strongly focussed on developing the capability to predict, in a holistic way, the multiple effects of land and water management decisions across large catchments. I believe our technical effort in this area is distinctive internationally, in terms of its breadth and quality, and particularly in terms of the industry-need focus that underpins it. The integrated catchment modelling capability we regarded as a pipe-dream five years ago is now within our reach and will be delivered by the end of our current CRC term in 2006. However, already we have some great modelling products ready to go and we want to get them used in catchment management circles as soon as possible. Getting adoption is arguably tougher than developing the technology in the first place. That's why we have Communication and Adoption, and Education and Training strategies built into our game plan.

We believe that our modelling technology is great and necessary, but we have to demonstrate its virtues before people will adopt it into practice. Hence, in January next year we will launch a number of 'Development Projects' aimed at building capacity within the NRM sector to apply and evaluate our modelling tools. We will be running training workshops, assisting industry staff in the application of our models to their 'home turf' and responding to industry recommendations on model revisions. Importantly, our modelling tools and the design of our Development Projects, cater for broad-based stakeholder involvement. We are casting our tools purposefully in such a way that catchment stakeholders can relate to them.

It is our hope that current and future NRM initiatives like the National Action Plan and Salinity and Water Quality will embrace our tools and integrate them into catchment management planning.

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COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

# NEW TECHNICAL REPORT

## THE STATUS OF CATCHMENT MODELLING IN AUSTRALIA

by

Frances Marston
Robert Argent
Rob Vertessy
Susan Cuddy
Joel Rahman

**Technical Report 02/4**

The CRC for Catchment Hydrology is developing a new generation of catchment models and modelling support tools, integrated within a system of software known as the Catchment Modelling Toolkit. The purpose of the Toolkit is to improve the standard and efficiency of catchment modelling, and to provide much-needed enhancements in predictive capability for catchment managers.

This report describes a vital element of the planning underpinning the development of the Toolkit concept. It summarises the results of three different surveys that gauged the opinions of catchment managers, model users and model developers with respect to the status of catchment modelling in Australia.

**Copies are available through the Centre Office for $27.50**

PROGRAM 1

# PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

**Report by Rodger Grayson and Robert Argent**

**Project 1B**
**Integration – enough with the rhetoric, let's do it!**

The October 2001 *Catchword* was a special issue devoted to integration, and Russell Mein began his editorial with a quote from Tom Hatton – *"Integration will be the biggest challenge for the CRC for Catchment Hydrology"*. Indeed it could be argued that a major measure of the success of the CRC will be how well we genuinely integrate the outcomes of 14 years of activity to address the natural resource management issues of today and the future. Integration is central to our fulfilling the mission of the CRC, yet there is not an example anywhere in the world where integration on the scale we are proposing has been clearly illustrated – Tom wasn't joking! - we have to roll our sleeves up!

*Integration blueprint*

To this end, the past few months has seen a flurry of activity by Program Leaders and proponents of final round projects, aimed at maximising our chances of meeting this challenge by building integration into the structure of new projects. The August 2002 Board meeting approved an early start for Project 1B (Methods for integration in catchment prediction) with a view to helping build integration activities into the new project agreements and work with program and project leaders to construct an "integration blueprint". This 'blueprint' is intended to show not only how the various projects conceptually link together and interact, but detail the actual information that needs to flow from one "module" to another.

*Model development and delivery*

A primary vehicle for integration in the CRC is model development and delivery via the toolkit. Rob Vertessy outlined a vision for the toolkit in the special issue last year where he talked about the linking of data, models and support tools to tackle major natural resource management issues. We can think of Rob's vision as a jigsaw, where the pieces are made up of outputs from all the projects over the life of the CRC. But until recently, most of these pieces have not been shaped with the intention of fitting together, they do a great job at their particular task, but many need some reshaping to become part of the whole picture. For the new projects, we can identify the shape they need to be up-front.

*Talking the same language*

The integration team and Program Leaders have met several times over the past two months to shape the pieces of the jigsaw and try to fill any big gaps in the overall picture. A lot of this effort has been directed at ensuring we are all "talking the same language". Are the flow and water quality effects of land-use change coming from one project in the right form and at the right scale to act as input to perhaps an economics or river health module being developed by another project? To some, "land-use change" means a change in the mix of cropping over an irrigation area, while to others it means changes from forest to pasture or vice versa. This issue of language is best illustrated by a simple example. A key issue of interest is the effects of land use change on water resources and the subsequent impact on irrigation supply and environmental flows. The new project 2E will provide information on the effects of such changes on river flow-duration curves, but other projects need to know the effects on daily flow sequences. So we need a project (5A in this case) to develop parameters for rainfall-runoff models that reflect these changes in flow-duration curves and can be used to generate daily flow for use by others such as Program 3 (where the effects on water allocation and economics are modelled), or Program 6 (where the effects of environmental flows and channel behaviour will be modelled). An outcome of the Program 3 modelling might be a new mix of land uses (adjusted to the new flow behaviour) that then needs reassessment for the catchment-scale effects on flow behaviour by 2E and so the cycle continues. When we throw in water quality, channel/riparian issues etc., we ramp up the complexity of the interactions and need to be very clear that we really will be able to use the outputs of one project as input to another.

*Aggregating/disaggregating outputs*

Another example of "talking the same language" relates to sediment generation and transport where the primary tool for catchment scale assessment will be SedNet. But SedNet presently produces annual values, while other projects require daily time series. So a key task for the coming round of projects will be developing ways to disaggregate (and in some cases aggregate) the outputs of one modelling method in a physically sensible way that enables it use by others. The efforts of the integration team and program leaders over the last couple of months have been aimed at identifying as many of these "issues of language" as we can, and include tasks in our project agreements that ensure they will be addressed.

*Strengthening links between projects*
As we make the links between projects stronger and stronger, we introduce new challenges such as matching the timing of project outputs to avoid "blockages on the critical path". Part of the integration activities to date have included program and project leaders looking across all the outcomes identified in project agreements to ensure that they can deliver their products when others need them and vice versa. Development projects will be another avenue for integration activities, providing a practical context for seeing whether the toolkit will be up to the challenge of tackling real-world NRM issues.

By the time you read this, the project agreements will be going to the Board and the die will be cast for the final push to meet the CRC's mission. The commitment of program and project leaders, and the efforts in the development of project agreements, not to mention the Director's catchcry of "no integration, no dollars", put us in a great position to meet the integration challenge – let's do it.

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PROGRAM 2

## LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

### Report by Jon Olley

### Organic carbon supply to a large lowland river, and why it matters?

*Background*
In rivers and other aquatic systems the sources, transport, and transformations of phosphorus (P) and nitrogen (N) are intimately linked with those of organic carbon (C).

If we are to understand the behaviour of these nutrients in large river systems we need to understand the sources and fate of organic carbon. The supply of organic carbon to large river systems is generally poorly understood. At issue are the relative contributions of in-channel, headwater catchment and floodplain primary production, and how these contributions vary with flow conditions. Recent work has indicated that fine suspended particulate organic matter FSPOM is the most important form of carbon for riverine aquatic food webs. As part of a program of work aimed at improving our understand of the behaviour these nutrients, the CRC for Catchment Hydrology has just completed a two year study into the supply and transport of FSPOM and associated phosphorus and nitrogen in the Murrumbidgee River. Here I report on the organic carbon part of the story.

*How it was done*
Stable carbon isotope ratios and C/N ratios were used to distinguish between organic matter derived from catchment soils, catchment vegetation, and in-channel primary production. Radiocarbon dating was used to determine the age of the organic matter in the FSPOM. Samples of FSPOM were collected from along 1000 km of the main channel during a 1 in 10 year flood event and on five occasions during non-flood flows. Samples of surface and subsurface soil were collected from sites selected to cover the full range of rock types and land-uses in the mid-region (the primary source area for sediment to the lower river). To ensure that soil samples were representative, some 25 sub-samples were taken at each site; these were then combined to give one subsoil and one topsoil sample from each site. Samples of leaf litter and grasses were collected from the soil sampling sites and combined to provide a single sample of leaf litter and a single combined sample of grass. Leaves were also collected from river Red Gums which are the

## RECENT TECHNICAL REPORT

### CATCHMENT SCALE MODELLING OF RUNOFF, SEDIMENT AND NUTRIENT LOADS FOR THE SOUTH-EAST QUEENSLAND EMSS

by
**Francis Chiew**
**Philip Scanlon**
**Rob Vertessy**
**Fred Watson**

**Technical Report 02/1**

In a jointly-funded study, the South East Queensland Regional Water Quality Management Strategy and the CRC developed an Environmental Management Support System (EMSS) to simulate runoff and pollutant movement across the South East Queensland region.

This report summarises a vital part of the research that went into the development of the EMSS. It describes the runoff and pollutant load model used in the EMSS and recommends model parameter values for use in the South East Queensland region.

**Copies available through the Centre Office for $27.50.**

# RECENT TECHNICAL REPORT

## ESTIMATION OF POLLUTANT CONCENTRATIONS FOR EMSS MODELLING OF THE SOUTH EAST QUEENSLAND REGION

by

**Francis Chiew**
**Philip Scanlon**

**Technical Report 02/2**

In a jointly-funded study, the South East Queensland Regional Water Quality Management Strategy and the CRC developed an Environmental Management Support System (EMSS) to simulate runoff and pollutant movement across the South East Queensland region.

This report summarises a vital part of the research that went into the development of the EMSS. It recommends appropriate pollutant loading values for adoption in the EMSS. The work reported here is based on a very extensive data-mining exercise where the authors scoured reports and databases compiled by several organisations and scientists. In so doing, they have added significant value to work initiated by others.

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dominant riparian tree species along the studied reach. Freshwater algal samples were not collected during this study and literature values were used.

*What the data showed*

All of the data from the FSPOM samples collected during a 1-in-10 year flood event fell within the bi-variate space of the soils data (see Fig. 2.1), even for samples that were collected during flow recession. This indicates that during the flood, soil organic matter dominates the carbon in the FSPOM along the river. In contrast the carbon isotope ratio ($\delta^{13}C$) and C/N ratio data from the FSPOM samples collected during non-flood flows were clearly separated from the soil data – indicating that the organic component in these samples is not the same as that in the soils (Fig.2.1). The data indicated that the samples consisted of a mix of soil organic matter, catchment vegetation and in-channel derived carbon. Using a three component mixing model it was shown that the in-channel derived component increased with distance downstream (Fig. 2.2c) while the carbon derived from the soils and C3 vegetation decrease. The radiocarbon dating indicated that in-channel primary producers were on average using terrestrial material photosynthesized from the atmosphere 40 to 50 years ago, indicating that there are significant stores and delays in the system.

*Implications for carbon supply to aquatic ecosystems*

The data presented supports a model carbon supply to the FSPOM to the Murrumbidgee River in which catchment soil sources dominate during flood events, even during flow recession when waters return from the floodplain. During non-flood periods, riparian vegetation and catchment soil sources in the tributary catchments are important carbon sources to the FSPOM in the upper reaches of the main channel. During transport downstream much of this carbon is metabolised and enters the dissolved phase. Carbon derived from the break down of soil organic matter deposited along the river during the flood periods also enters the dissolved phase. In-channel primary producers then preferentially incorporate the isotopically light fraction from the dissolved phase back into the FSPOM. As the concentration of carbon in the FSPOM does not vary significantly along the river, the isotopically heavy carbon is lost to the atmosphere. This work clearly demonstrates that organic matter derived from catchment soils is a major carbon source to these large inland rivers. It reveals the importance of in-channel carbon cycling of terrestrial organic matter and in-channel primary production as a source of carbon to the FSPOM, and hence aquatic food webs. It also suggests that the lowland floodplain is not a significant source of carbon to these rivers and illustrates the importance of longitudinal processing of carbon.

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Or read

Olley, J.M. (2002) Organic carbon supply to a large lowland river and implications for aquatic ecosystems. In The structure function and management implications of fluvial sedimentary systems, eds. Dyer, F. Thoms, M. and Olley, J.M IAHS red book series, No 276. p 27-34

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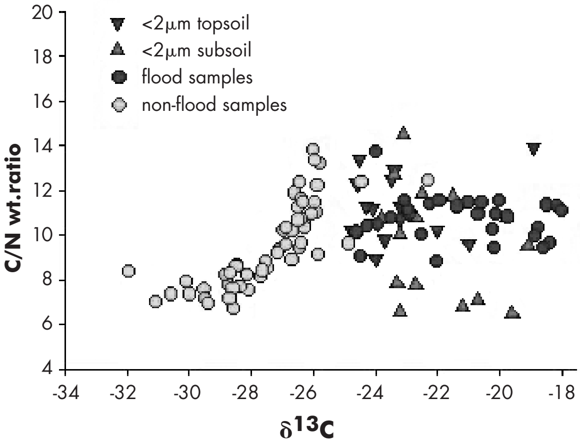


*Fig. 2.1: The $\delta^{13}C$ and C/N ratio in the <2µm fraction of soil samples and fine suspended particulate organic matter (FSPOM) samples collected from a large lowland river, the Murrumbidgee River, New South Wales, Australia. The samples of FSPOM were collected from along 1000 km of the main channel during a 1 in 10 year flood event and on five occasions during non-flood flows.*

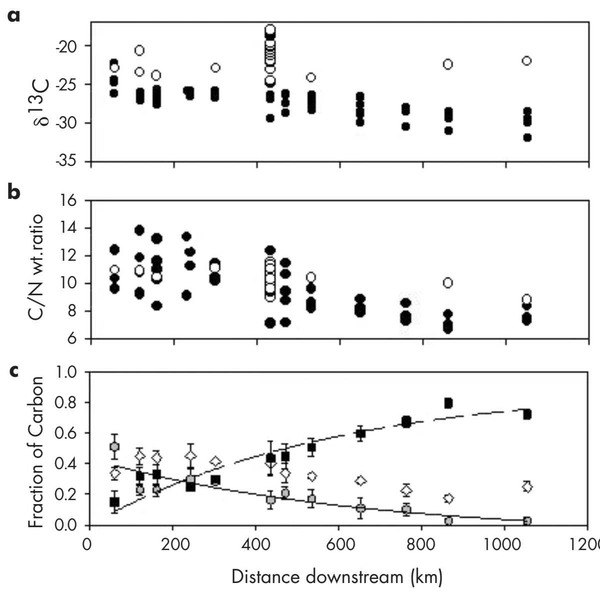


*Fig. 2.2: The $\delta^{13}C$(a) and C/N (b) ratios in samples of fine suspended particulate organic matter (FSPOM) collected from along 1000 km of the main channel during a 1 in 10 year flood event (open circles) and on five occasions during non-flood flows (closed circles). (c) The contributions, during non-flood flows, of carbon derived from in-channel production (closed squares), soil organic matter (grey hexagons), and C3-vegetation (open diamonds) to the FSPOM as a function of distance downstream calculated using a three component mixing model. End member values were chosen such that the estimated in-channel derived component is a minimum.*

## Report by Guy Geeves

### Plot scale runoff and small catchment streamflow

*Background – 'Downward modelling'*

Project 2.2: 'Managing pollutant delivery in dry and upland catchments' is focussed on pollutant delivery to streams within catchments undergoing changing land use. Early in the project we perceived a challenge to investigate the application of more "downward" modelling approaches to this issue. In response, we attempted a brief preliminary investigation using historic plot and small catchment streamflow data outlined here.

Downward approaches to hydrological modelling (eg. Zhang *et al.*, 1999) require substantial data sets. Direct measurements of concurrent sediment generation on hillslopes and sediment delivered to streams are not common. We assumed that comparison of hillslope plot scale overland flow with concurrent quick flow (streamflow minus baseflow) measured in streams may inform us on the relative efficiency of delivery of overland flow and hence suspended sediment delivery within catchments under different land use.

*Historical data*

We looked for concurrent historical data at plot and small catchment scale in the same location within NSW. The main source of plot data contrasting land use and land management in NSW is the historical data described by Edwards (1987) measured at six DLWC centres in the wheat and sheep belt. However, most of these data were collected in the period 1954 to 1975 when stream gauging efforts tended to be focussed on larger catchments for storage design. The preliminary investigation was consequently limited to DLWC Cowra CNR plot data and concurrent streamflow from five nearby smaller catchments covering a period from August 1971 to December 1975.

*Plot data*

The plot data consisted of daily runoff measured from triplicate plots (41.5 x 2.4m) located on an 8% slope Red Chromosol. Contrasting management treatments reflected the soil erosion issues of that time with treatments representing pasture and wheat/volunteer pasture rotations at intensities of 1 in 2 years, 1 in 3 years, and 2 in 4 years.

*Selected catchments*

Waugoola Ck catchment encompasses the Cowra site whilst the other catchments used are within 40 km of Cowra. The five catchments range in topography, soils and land use. Potentially of greater hydrological significance is the much greater rainfall over the period for Canomodine Ck and the slightly greater rainfall for Hovell's Ck reflected in the values of potential evaporation to precipitation ($E_O$/P) for the period in Table 2.1.

*Rainfall*

Daily rainfall data were obtained from Cowra CNR records for Waugoola Ck. and from QDNR data drill for a central point in each other catchment. Daily streamflow data were filtered using the method of Lyne & Hollick as described by Grayson *et al.* (1996) to approximate stream quick flow. Historic land use was based on anecdotal advice from local DLWC and NSW Agriculture staff. Runoff from small plots, rainfall, streamflow and quick flow were analysed seasonally.

*Runoff*

Plot runoff at Cowra over the period varied considerably within a cropping system depending on the phase within the rotation. Three large runoff events within a ten day period in early 1973 dominated hillslope runoff for most plots, reflecting the episodic nature of overland flow on hillslopes. These events were associated with significant rainfall events and significant stream quick flow events in all catchments.

*Stream quick flow*

Total stream quick flow for Waugoola Ck over the period (118 mm) was not grossly inconsistent with the total hillslope runoff measured at Cowra for the relevant reconstructed historical catchment land use (69 mm). At face value this might suggest relatively efficient delivery of hillslope runoff to the stream. However, examination of the record indicates that if the ten day period referred to above was disregarded, then measured hillslope

*Table 2.1. Catchment Parameters*

| Catchment | Area (km2) | $E_O$/P | Historic Land use/Land Mgt |
|---|---|---|---|
| Waugoola Ck. | 350 | 1.43 | 30% pasture; 70% cropping |
| Nyrang Ck. | 225 | 1.35 | 15% pasture; 80% cropping; 5% trees |
| Hovell's Ck. | 272 | 1.02 | 90% pasture; 5% cropping; 5% trees |
| Canomodine Ck. | 132 | 0.75 | 75% pasture; 20% cropping; 5% trees |
| Goonigal Ck. | 363 | 1.43 | 30% pasture; 60% cropping; 10% trees |

## NEW TECHNICAL REPORT

### OPTICAL PROPERTIES OF LEAVES IN THE VISIBLE AND NEAR-INFRARED UNDER BEAM AND DIFFUSE RADIANCE

**by**

**Iain Hume**
**Tim McVicar**
**Michael Roderick**

**Technical Report 02/3**

Land-use impacts on the water balance and regional hydrology through vegetation. Agricultural and natural resource managers therefore need to know the amount of understorey and overstorey vegetation in these woodlands. Remote sensing has a role in this assessment.

This report describes laboratory studies to determine if the remote sensing signature of tree and grass leaves differ enough to allow them to be unmixed using broad-band satellite data. Additionally, further understanding of the way understorey and overstorey leaves absorb diffuse and beam light was developed. These results provide an avenue forward for remote sensing in this difficult area.

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## NEW TECHNICAL REPORT

### THE DEVELOPMENT OF WATER REFORM IN AUSTRALIA

by

John Tisdell
John Ward
Tony Grudzinski

**Technical Report 02/5**

The first phase of the CRC Project 3.2 'Enhancement of the Water Market reform Process' was to gather background information on water management in Australia, and water reform and water trading in particular. Part of this important process is to gain an overview of the nature of water, a history of water management in Australia, and current literature on water reform. This report is a summary of that overview and contributes to a greater understanding of water management in Australia and its future.

**This report is now available from the Centre Office for $33.00.**

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runoff was only equivalent to approximately one sixth of the stream quick flow. This was also the case for Nyrang Ck. and Goonigal Ck whilst the proportion was closer to one twelfth for the wetter catchments of Hovell's Ck. and Canomodine Ck. The excess of stream quick flow over observed hillslope runoff could be explained either by spatially variable rainfall resulting in hillslope runoff elsewhere in the catchment and not at the Cowra plots, or by runoff from near-stream saturated areas not represented at all by the plots. Either way, daily streamflow records could not, in this case, reliably inform us on hillslope runoff.

*Outcomes*

Clearly the study was limited by the necessity to partition daily streamflow accurately. We considered alternatives for partitioning of quick flow and partitioning of saturated area runoff, as well as more rigorous reconstruction of catchment land use/management and more detailed aerial rainfall estimation. However, on balance, it was decided that the lack of concurrent data from plots and nearby catchments with distinct and quantifiable land-use contrasts could not be satisfactorily overcome and the preliminary study was not extended.

*References*

Edwards, K. (1987). Runoff and Soil Loss Studies in New South Wales. Technical Handbook 10, Soil Conservation Service of NSW, Sydney.

Grayson, R.B., Argent, R.M., Nathan, R.J., McMahon, T.A., and Mein, R.G., (1996) Hydrological Recipes: Estimation Techniques in Australian Hydrology. CRC for Catchment Hydrology, Clayton. Vic.

Zhang, L., Dawes, W.R., and Walker, G.R., (1999). Predicting the Effect of Vegetation Changes on Catchment Average Water Balance. CRC for Catchment Hydrology Technical Report 99/12.

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PROGRAM 3
## SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

### Workings of experimental water markets and allocation simulations

*Introduction*

This article outlines the basic workings of the experimental water markets developed in Project 3.2: 'Enhancement of the water market reform process'. The technique is gaining international interest as a way of exploring the implications of alternative mechanisms for dealing with environmental issues associated with water extraction and trading.

*Experimental arrangements*

Water extraction decisions and trading happen over the Internet or in face-to-face workshops. Participants are provided with a model farm and allocation of water. Their objective is to maximise the income they earn by wisely managing their water allocation. In order to make the decision process salient, the participants are paid according to their farm's income. For farmers participating in the focus catchments, this is in the form of cash. Students are paid in University bookshop vouchers (or research account payment for postgraduates).

*Trials with farmers*

The farm models and decision process used has been extensively trialled with farmers. Each player has an allocation of water that they can draw from the water authority. They can also buy or sell water in the water market. There is one trading period each month. During each month it may rain which will alter the amount of water they need to use that month. They are given historical median rainfall and at the end of each month (trading period) they will be told they actual rainfall.

*Options for water use*

Each player has four options:

- Use water to meet their crop's maximum water requirement;
- Irrigate less than maximum but greater than or equal to the crop's minimum water requirement;
- Reduce the area of land irrigated; or
- Not irrigate their crop at all and play solely as a water trader.

*Meeting crop requirements*

Meeting the crop's minimum water requirement each month maintains the whole crop. If they decide to irrigate below the minimum crop requirement, the area of irrigated land is proportionally reduced. The potential income from the irrigated land now fallow is lost for the whole year. They will also have new minimum and maximum water requirements for the rest of the year. Rainfall figures will also be reduced as less rain will fall on they smaller area of crop.

*Simulation approach*

The simulation technique has been used to evaluate alternative auction structures for the distribution of new water entitlements that may arise as a result of the WAMP process in the Fitzroy catchment and the definition of regulated groundwater in the Goulburn Broken catchment.

At present the methodology is being used to evaluate alternative auction structures and various types of information and communication that may influence how river management committees and similar organisations may engage the irrigators in meeting environmental flow targets.

Below is an example of one of the sheets seen by the player. An example of the instructions are found at: www.ens.gu.edu.au/johnt/mwater/instructions.ppt

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*Figure 3.1. Basic farm information*

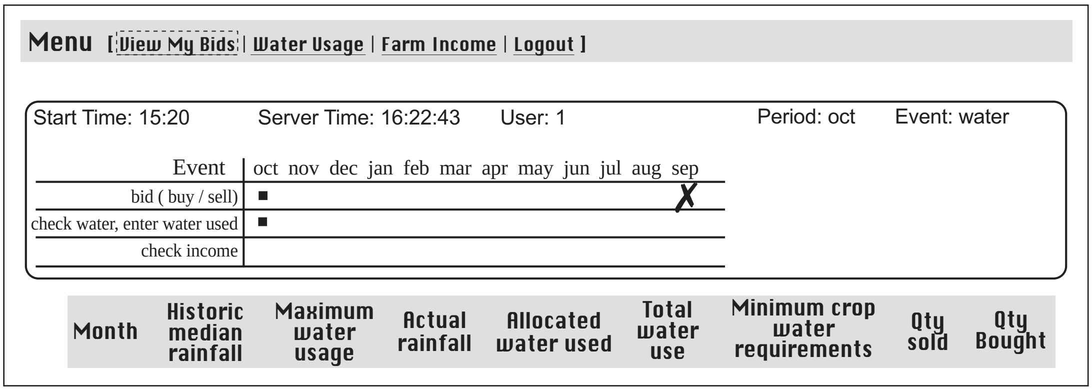



*Figure 3.2. Water usage*

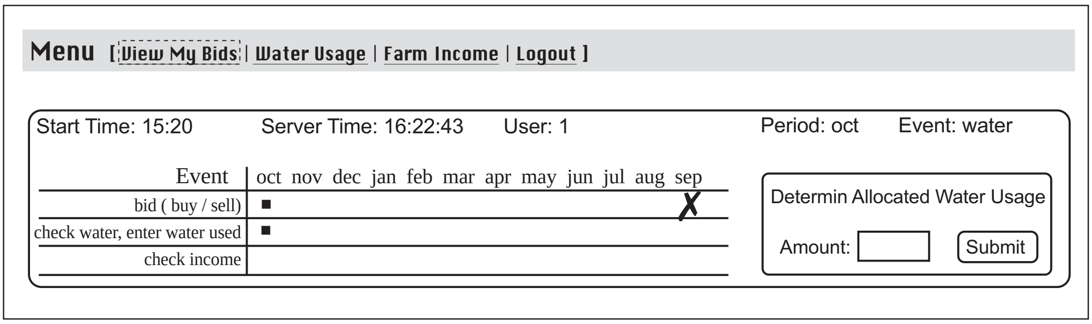
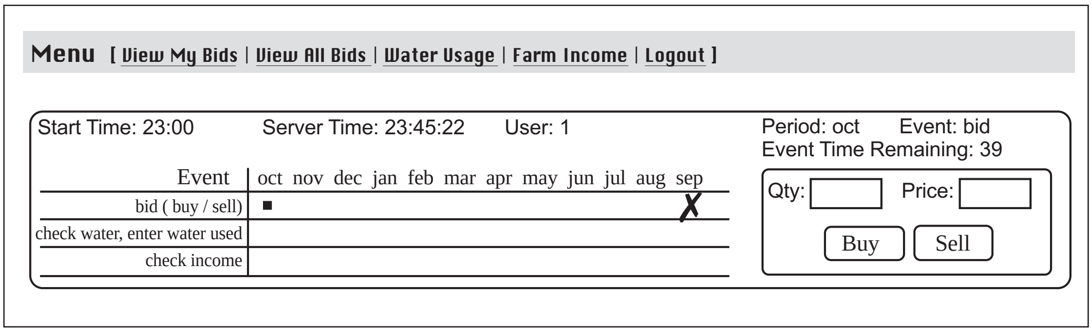



*Figure 3. Trading water*




# NEW TECHNICAL REPORT

## WATER TRADING IN THE GOULBURN-MURRAY IRRIGATION SCHEME

by

**Wijedasa Hewa Alankarage**
**Hector Malano**
**Tom McMahon**
**Hugh Turral**
**Garry Smith**

**Technical Report 02/9**

This CRC report presents the outcomes of a study of permanent and temporary water trading in irrigation areas within the Goulburn-Murray Irrigation Scheme (GMIS). The study is based on a survey of permanent and temporary water traders in the GMIS from March to May 2001 and past water records of the GMIS. Outcomes of studies in the area based on two previous surveys conducted in 1994 and 1996 and an irrigation farm census conducted in 1997 have also been compared.

**This report will be published during November and will cost $27.50 including GST, postage and handling.**

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

# NEW WORKING DOCUMENT

## NON-STRUCTURAL STORMWATER QUALITY BEST MANAGMENT PRACTICES - GUIDELINES

by
André Taylor

**Working Document 02/6**

This working document presents a new evaluation framework 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. In addition, monitoring protocols and data recording sheets have been developed to support each style of evaluation.

**A printed and bound copy of this report is available from the Centre Office for $22.00 including GST, postage and handling.**

**The report is also available as an Adobe pdf file and can be downloaded from http://www.catchment.crc.org.au/publications**

PROGRAM 4
**URBAN STORMWATER QUALITY**
Program Leader
TIM FLETCHER

## Research in urban water cycle management - perspectives from north and south

*Benchmarking our research*

The Cooperative Research Centre for Catchment Hydrology is involved in targeted research, aimed at giving water managers the information and tools necessary to assess and manage land and water use impacts.

To ensure our research remains world class, we spend significant time benchmarking our own approach against that of others, both in Australia and overseas. The Urban Stormwater Quality team has recently been represented at two key conferences:

- The 2nd Water Sensitive Urban Design Conference, held in Brisbane (2-4 September 2002)
- The 9th International Conference on Urban Drainage, held in Portland, USA (8-13 September 2002).

Attendance at these conferences gave CRC scientists the opportunity to present our research to both our scientific peers, and our industry audience. It also allowed us to review the work being conducted by others, and to explore opportunities for collaborating with them, with the aim of making "the whole greater than the sum of the parts".

In this article I will summarise the outcomes of each conference, and give some perspective of where we sit in relation to urban water cycle management approaches elsewhere.

*Second Water Sensitive Urban Design Conference*

- Case studies

  The first Water Sensitive Urban Design (WSUD) conference was held in Melbourne in 2000. Much attention in that conference was paid to the institutional and other impediments to adoption of WSUD (Lloyd, 2001). Two short years later a far more mature industry is apparent, evidenced by the large number of case studies presented. These case studies highlighted the lessons learnt from WSUD projects which have been conceptualised, designed and constructed. Research conducted by many organisations, including the CRC, has contributed to this learning process, and is significantly reducing the uncertainty associated with the application of WSUD principles, both in new developments and in retrofit situations.

- Integrated urban water cycle management

  At the first WSUD conference in 2000, the issue of integrated urban water cycle management was raised. In the 2nd conference, this was a dominant theme, with the integration of urban stormwater management, stormwater harvesting, water re-use, and waste water management given strong emphasis (e.g. Barter, 2002; Coombes & Kuczera, 2002; McAlister & Cavanagh, 2002; Mitchell, 2002). Case studies in Brisbane contained many demonstrations of this, with effective leadership being shown by Brisbane City Council, through its Corporate Plan. The adoption of rainwater tanks for non-potable water supply, for example, is encouraged by a Brisbane City incentive scheme.

- Landscape objectives

  Another strong theme in the conference was the integration of landscape objectives within WSUD. Whilst this had also been a theme at the 2000 conference, the demonstration of this objective by real case studies was a highlight (Eadie, 2002; Mongard, 2002). Papers were presented which highlighted the integration of WSUD elements into city buildings, streetscapes in both medium and high density urban areas, and even on roofs (roof-gardens). In all cases, the application of WSUD became a highly attractive landscape feature, contributing to the positive public reaction to its implementation.

- Non-structural measures

  The conference also gave recognition to the important role of non-structural measures in meeting WSUD objectives, and reported the performance of some non-structural approaches from around the world (Taylor & McManus, 2002). This theme added weight to the argument for integration and multi-disciplinary approaches in urban water cycle management and WSUD.

- Audience

  A further demonstration of the widespread adoption and development of WSUD within Australia was the composition of the audience. Attendees included a broad cross-section from Local Government, State Government agencies, consultants, developers, stormwater industry suppliers, and academics.

The overall impression from this conference was a sense that WSUD is now being commonly applied throughout much of Australia, and that many of the impediments to its adoption identified in the 2000 conference are being gradually overcome. The 3rd conference, to be held in Sydney, in 2004, should be well worth attending!

*9th International Conference on Urban Drainage*

- History

  Despite its uninspiring name, the International Conference on Urban Drainage is widely regarded as a 'keystone' conference on the management of urban stormwater and its impacts. The first one was held in the United Kingdom in 1978, with the 1999 conference being held in Sydney. The conference is very popular, with attendance by over 500 people at the 9th conference, in Portland, Oregon.

- Themes

  Being such a large conference, there were many themes running, and these concisely summarise the conference's scope:
  - Best management practices - combined sewer hydraulic devices & modelling
  - Best management practices - low impact development (equivalent to "WSUD")
  - BMPs - wetlands, ponds, infiltration systems, porous pavement
  - Modelling - decision support and modelling (including GIS)
  - Stormwater management tools
  - Rainfall measurement and analysis
  - Institutional arrangements and community participation
  - Infiltration to combined sewer and storm sewers
  - Urban stream restoration and management
  - Characterisation and treatability of urban stormwater
  - Urbanisation impacts on streams
  - Hydraulics
  - Monitoring, evaluation and control systems
  - Flood management and modelling

- Research emphasis

  The conference had a strong emphasis on reporting recent research findings from around the world. The proceedings form a very powerful reference for CRC researchers in the Urban Stormwater Quality Program, as we commence our next round of projects (from January 2003).

- CRC representation

  The CRC was very well represented, with six papers presented. The papers assisted in outlining our research activities, and demonstrating MUSIC (Model for Urban Stormwater Improvement Conceptualisation) to the international audience.

  Tony Wong presented two review papers. The first one, entitled "Urban Stormwater Management and Water Sensitive Urban Design in Australia" (Wong, 2002), summarised WSUD research, policy and practice in Australia, and contained some consistent themes similar to review papers presented from around the world. The other paper, "Recent Advances in Australian Practice on the Use of Constructed Wetlands for Stormwater Treatment" (Wong & Breen, 2002), summarised research undertaken by the CRC since 1993, focussed on improving and predicting the performance of stormwater treatment wetlands. This paper showed research which is genuinely world-leading, and was consequently well received.

  CRC research on pollutant characterisation was presented in a paper by University of Melbourne PhD student Muthukaruppan Muthukumaran *et al.* (2002). This paper described the characteristics of urban stormwater pollutants emanating from urban catchments of varying geology, and quantified the relationship between particle size and contaminant concentration. The results provide useful guidance for the design of stormwater treatment measures aimed at treating particular pollutant types.

  Research undertaken at Griffith University (Greenway *et all.*, 2002) on the behaviour of stormwater pollutants through a range of subcatchments and treatment measures was also presented. A summary of performance tests on vegetated swales, conducted by Brisbane City Council and the CRC in Brisbane (Fletcher *et al.*, 2002) was also included.

- MUSIC

  The presentation of MUSIC was conducted 'live' at the conference, based on a hypothetical case-study in Portland, treating local stormwater discharging to the local Willamette River (Wong *et all.*, 2002). Audience reaction to the model was very positive, and many enquiries for its purchase have resulted. More importantly, a number of researchers have noted their interest in collaborating on the further refinement of MUSIC, and its calibration for other locations. These opportunities for international collaboration are currently being pursued, with the same basic goal: to ensure that our research remains world-class, and maximises the benefits to land and water managers in Australia.

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# NEW INDUSTRY REPORT

## WATER SENSITIVE URBAN DESIGN: A STORMWATER MANAGEMENT PERSPECTIVE

by

Sara Lloyd
Tony Wong
Chris Chesterfield

**Industry Report 02/10**

In response to the need for reliable, cost-effective, environmentally-friendly, robust and aesthetically-pleasing stormwater treatment measures, the CRC for Catchment Hydrology undertook research to develop new and existing stormwater quality improvement practices. The integration of these and other water conservation practices into urban design is referred to as Water Sensitive Urban Design (WSUD) and its principles can apply to individual houses and streetscapes or to whole catchments.

Fundamental to successfully applying WSUD principles to urban development is an understanding of the performance capabilities of structural stormwater management strategies, their life cycle costs and market acceptance. This report centres on the design process, construction activities and monitoring of environmental, social and economic performance indicators associated with Lynbrook Estate's Demonstration Project.

**This report is available through the Centre Office for $33.00 (includes GST, postage and handling).**

# NEW 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 June 2003. The CRC for Catchment Hydrology is committed to updating MUSIC annually until at least 2006. Subsequent versions of MUSIC may be charged for.**


Eadie, M. (2002). *Taking it to the Streets: Integration of WSUD into the Public Realm*. Paper presented at the Second National Conference on Water Sensitive Urban Design, Brisbane, Australia, 2-4 September, 2002

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Muthukumaran, M., Chiew, F., & Wong, T. H. F. (2002). *Size Distribution and Partitioning of Urban Pollutants*. Paper presented at the 9th International Conference on Urban Drainage (Extended Abstracts), Portland, Oregon, USA, pp. 172.

Taylor, A., & McManus, R. (2002). *Power of Non-structural Measures for Implementing Sustainable Water Sensitive Urban Design Solutions.* Paper presented at the Second National Conference on Water Sensitive Urban Design, Brisbane, Australia, 2-4 September, 2002

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Wong, T. H. F., Fletcher, T. D., Duncan, H. P., Coleman, J. R., & Jenkins, G. A. (2002). *A Model For Urban Stormwater Improvement Conceptualisation*. Paper presented at the 9th International Conference on Urban Drainage (Extended Abstracts), Portland, Oregon, USA, pp. 598.


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PROGRAM 5

**CLIMATE VARIABILITY**

Program Leader

FRANCIS CHIEW

## Deliverables from Climate Variability Program

As the first three years of CRC projects are drawing to a close, it is a good opportunity to summarise the key "products" from the Climate Variability Program that have been developed for use by researchers, CRC industry participants and people involved in the land and water resources management disciplines. The research, development and testing of these products have been discussed in previous newsletters.

*Point stochastic models*

Programmers in Program 1 'Predicting catchment behaviour ' and researchers in Project 5.2: 'National data bank of stochastic climate and streamflow models': are currently developing a stochastic model library that will be part of the CRC modelling toolkit. The library will have a suite of stochastic models for generating climate data at a point down to a daily time scale. The models, which will allow users to generate stochastic data that preserves the statistics of the historical data, have been selected based on research in Project 5.2. For annual rainfall, the lag-one autoregressive model (AR1) with parameter uncertainty will be used. For monthly rainfall, the modified method of fragments (MMF) and the nonparametric monthly model (NMM) will be used. For daily rainfall, the transition probability matrix model with Boughton correction (TPMb) and a simplified version of the daily monthly model (DMM) will be used. For daily climate (mainly maximum temperature and pan evaporation), a multivariate model conditioned on the rainfall state will be used.

*Space-time design model*

The multi-cascade space-time rainfall model, MOTIVATE, is now available as a user-friendly software. MOTIVATE gives stochastic realisations of spatial and temporal rainfall for design storms (for a given areal-average rainfall amount and duration). The model has been calibrated for Sydney, Melbourne, Darwin and the Brisbane area.

*Rainfall nowcasting model*

The Spectral Prognosis (SPROG) model is now available for forecasting very short-term rainfall (up to two hours). The research focus for the remainder of the year is on the development of an operational radar data processing and nowcasting system that can be used by the Bureau of Meteorology in capital cities. The operational system will be tested over an extended period prior to being adapted by the Bureau.

*Seasonal forecasting model*

Project 5.1: 'Modelling and forecasting hydroclimate variables in space and time' has developed a nonparametric model for forecasting streamflow and tested the model using streamflow data across Australia. The model gives forecasts of streamflow several months in advance based on El Nino-Southern Oscillation indicators and/or the serial correlation in streamflow. The forecasts are expressed as exceedance probabilities, details which are needed for use in the management of conservative low-risk water resources systems. The seasonal forecasting model will be programmed as a user-friendly software for inclusion in the CRC modelling toolkit.

*Stochastic downscaling of rainfall*

Project 5.1 has also developed parameters for a downscaling methodology that relates rainfall in the Murrumbidgee River catchment to weather states defined by atmospheric predictor variables. The method gives multiple stochastic realisations of daily, multi-site weather under a number of climate scenarios.

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# NEW TECHNICAL REPORT

## STOCHASTIC GENERATION OF ANNUAL RAINFALL DATA

by

**Ratnasingham Srikanthan**
**George Kuczera**
**Mark Thyer**
**Tom McMahon**

**Technical Report 02/6**

One of the goals of the Climate Variability Program in the CRC for Catchment Hydrology is to provide catchment and river managers, and other researchers in the CRC, with computer programs to generate climate data. The need is for this at time scales from less than one hour to a year, and for point sites through to large catchments like the Murrumbidgee and the Fitzroy. Our first report (CRC Technical Report 00/16) in this series is a comprehensive literature review; in it a number of techniques are recommended for testing.

This is the first of several reports assessing stochastic data generation techniques. It includes tests of several models to generate stochastically annual rainfall data at 44 sites across Australia.

**Copies of this report are available through the Centre Office for $27.50 (includes GST, postage and handling).**

## NEW TECHNICAL REPORT

### ON THE CALIBRATION OF AUSTRALIAN WEATHER RADARS

by

**Alan Seed**
**Lionel Siriwardena**
**Xudong Sun**
**Phillip Jordan**
**Jim Elliott**

**Technical Report 02/7**

Weather radar offers an enormous potential to improve the quality of rainfall measurement. This potential can translate into benefits in many sectors of the water industry ranging from improved design information, decisions on water allocation and management, through to improved weather and flood forecasts for greater public safety.

A key step in transforming weather radar observations into accurate rainfall estimates however is the calibration of the weather radar data. This involves converting the quantity actually observed by the radar (known as reflectivity) into an estimate of rainfall intensity. The current approach used widely with Australian weather radars is to rely on a set of calibration factors that represent average, or climatological, conditions. This can lead to quite large errors in rainfall estimates.

This report describes investigations to improve the calibration process for weather radars in Melbourne, Sydney and Darwin. Rain gauge data has been used to analyse the likely errors in rainfall estimates from radar and calibration strategies to improve the quality of the radar rainfall estimates are proposed.

**Copies of this report are available through the Centre Office for $27.50 (includes GST, postage and handling).**

PROGRAM 6

## RIVER RESTORATION

Program Leader
MIKE STEWARDSON

### Report by Michael Stewardson, Tony Ladson and Ian Rutherfurd

#### Evaluating the effectiveness of river restoration

*Introduction*

Project 6.1 of the River Restoration Program is developing criteria and concepts for planning the evaluation of stream rehabilitation projects. The motivation for this project is the common complaint that there is insufficient evaluation of stream restoration works. This demand for evaluation will grow as there is increasing investment in planning and delivering environmental flows, stabilisation works, riparian revegetation and, more recently, reintroduction of large woody debris.

As Ian Rutherfurd pointed out in the February 2002 *Catchword*, evaluation can take different forms. This article continues the discussion of evaluation by commenting on two different types of evaluation:

- Evaluation for reporting, and
- Evaluation for learning

Evaluation for reporting can involve evaluating project delivery ("Did you do what you said you would?") or evaluating project effectiveness ("Are there more fish, better habitat, less erosion than before the project began?"). Evaluation for learning is more focussed on assessing the restoration technique. In this case we ask questions such as "Would this technique work in other rivers?" or "How could we do it better next time?"

The following sections are an overview of our current thinking on evaluation, drawing on Tony Ladson's work in evaluating river management works in the Mitchell River, and our involvement in a collaborative project with CRC for Freshwater Ecology to design a project to evaluate the effectiveness of habitat reconstruction for the Murray Darling Basin Commission.

*Evaluation for Reporting*

The simplest form of Evaluation for reporting is to measure what was actually done – yet in practice this is commonly lacking (Curtis *et al.* 1998). Borrowing from business, it is possible to develop and use a range of indicator types and targets for assessing project outputs (Table 6.1).

In our assessment of the effectiveness of river management works in the Mitchell Catchment (Ladson, 2002) we found that one major barrier to evaluation was the variability in documentation and the lack of archiving of river management data. Until recently, formal evaluation has not been a priority of river

*Table 6.1 – Indicator types and targets for assessing project outputs (after Rutherfurd et al. 2002)*

| Indicator type | Comment | Example Indicator | Example target |
|---|---|---|---|
| Delivery | Quantity of produce or service (within a time period) | Number of km of fencing in this years works program | 10 km by the end of 2003 |
| Responsiveness | Elapsed time to execute tasks | Amount of time required to respond to a report of a fish kill | 1 day |
| Productivity | Work per unit staff | Number of trees planted per day | 300 trees per day |
| Efficiency | Cost per unit of output | Cost per tree produced from a nursery | $1.50 per tree |
| Benchmark | Comparison with an external standard | Trees will be produced for the same cost as a commercial nursery | $1.30 per tree |
| Survival | Are the works still there? | Percentage of planted trees surviving after 2 years | 80% |
| Qualitative | External opinion about performance (within a time period) | Approval rating in an opinion poll | By 2003 51% of riparian landholders will approve of the work of authority |
| Awareness | Knowledge that others have about particular goals (within a time period) | Number of riparian landholders that know about incentives for riparian fencing | By 2004, 80% of riparian landholders will know that incentives are available |
| Adoption | Actions undertaken by others (within a time period) | Number of riparian landholders with riparian fencing | 75% of landholders will have at least some riparian fencing |

management authorities, which have been focussed on achieving works on the ground. Systems to preserve historical data are also lacking; for example, many of the photographs of past river management works and issues have not been archived and plans have been lost. Evaluation of works in the future depends on improved collection and management of information.

*Evaluation for Learning*

Whilst evaluation for reporting is important, it is evaluation for learning that can contribute most to the industry in the long-term. Unfortunately, it is also more difficult to undertake. This type of evaluation strengthens our understanding of how river management actions influence streams. Such evaluation projects are rare and are usually undertaken by a partnership of industry and research agencies.

The Murray Darling Basin Commission recently commissioned a CRC for Catchment Hydrology and CRC for Freshwater Ecology team to propose a method of evaluating the effectiveness of habitat reconstruction in streams within the Murray Darling Basin. This was an opportunity to focus the skills of a large multi-disciplinary team on the problem of evaluation for learning. What we thought would be a straightforward task turned out to be far from simple. To begin with, the experimental techniques used by the various disciplines involved (hydrologists, ecologists and geomorphologists) are quite different. For example, a geomorphologist might examine several river channels in different states of development to understand the evolution of channel form. Ecologists are more familiar with smaller-scale experiments in which treatments are controlled and replicated. A hydrologist might examine a long-term streamflow record to validate a model of runoff processes. The challenge was to agree on a new experimental protocol that would provide the knowledge required by river restorers to improve restoration planning in the future. Internationally, the science of river restoration is still very new and experimental methods are yet to become established.

*Approaches to evaluating river restoration*

We considered three different approaches to evaluating river restoration:

- Post-project evaluation: examining conditions at sites that have been subject to restoration sometime in the past.
- Combining management and monitoring: design a monitoring and evaluation program as a part of a current restoration project.
- Dedicated experimentation: design an experiment with the sole objective of improving our knowledge of restoration.

\- Post-Project Evaluation

In the February edition of *Catchword*, Ian Rutherfurd discussed evaluation of riparian revegetation. The obvious approach would be to learn about the effectiveness of revegetation by comparing sites that have been planted at different times. However, results from over 60 sites in north-east Victoria suggest that this unlikely to yield much certainty because of variability in the sites, the type of vegetation planted, and the confounding factors such as the different types of engineering works that have also been undertaken (for full details of this work see Ezzy, 2001). Evaluating the way restoration was undertaken in the past may not be relevant to understanding current practice. Our experience with evaluating riparian vegetation is common to other management interventions.

\- Combining Management and Monitoring

The second approach we considered is to include monitoring and evaluation as part of a current restoration project. There is considerable effort going into restoration projects already. We wondered if some extra resources could convert these projects into experiments. The conventional approach to such project is to undertake a monitoring program in parallel with the stream management work. In these conventional monitoring projects, evaluation is an "add-on" and "learning" from the project is secondary to the objective of meeting local management priorities. A difficulty with such projects is that they are seldom based on a thorough consideration of the ecological processes involved. Time and funding constraints demand a simpler appraisal of the problem and the adoption of "best management practices". Other problems include:

- unclear targets,
- complex management plans involving multiple activities staggered through time,
- selection of sites that are unusual (eg close to urban centres or subject to flood damage),
- insufficient time for pre-restoration monitoring, and
- undertaking remedial works before the evaluation is complete.

These problems can only be addressed if "Evaluation for Learning" is a primary objective of the management agency involved. With the support of the agency, it may be possible to transform a conventional monitoring project into an adaptive management experiment, in which the restoration program is deliberately designed as an experiment to improve knowledge of restoration ecology. A key

## CONFERENCE PROCEEDINGS

### THE THIRD AUSTRALIAN STREAM MANAGEMENT CONFERENCE - THE VALUE OF HEALTHY STREAMS

**27-29 August 2001**

**Brisbane, Queensland**

Copies of the Stream Management Conference proceedings are now available for sale from the Centre Office.

The 700+ page, two volume set contains over 120 papers. Copies cost $110 (includes GST and postage) and can be ordered by contacting the

**CRC Centre Office**
tel 03 9905 2704
fax 03 9905 5033
email
virginia.verrelli@eng.monash.edu.au

**Note: Limited copies of the Second Australian Stream Management Conference ($104.50 including GST and postage) are also available.**

# OTHER OUTLETS FOR CRC PUBLICATIONS

**In addition to the Centre Office, all CRC publications are available through the Australian Water Association (AWA) Bookshop in Sydney and the NRE Information Centre in Melbourne. They also stock a wide range of other environmental publications.**

**AWA Bookshop** (virtual)
contact Diane Wiesner
Bookshop Manager
tel: 02 9413 1288
fax: 02 9413 1047
email: bookshop@awa.asn.au
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element of successful adaptive management is a strong commitment by all parties to learning. In practice, this commitment can be difficult to achieve, particularly when the primary focus of managers is with meeting the interests of the community affected by the project. In particular, it is likely to be difficult to convince stakeholders of the importance of carrying out just one management intervention at project sites and selecting sites in a way that provides for strong inferential power rather than according to management priorities. Whilst adaptive management has considerable merit, it has rarely been used successfully in the case of river restoration (Walters, 1997). We considered adaptive management to be a useful adjunct to our MDBC evaluation project but could not be relied on as the core tool for undertaking the evaluation required by the MDBC.

- Dedicated Experimentation

The approach to evaluation which we recommended for the MDBC was to use a dedicated experiment designed to provide reliable and useful inferences regarding the performance of restoration techniques. These experiments should focus on a small number of treatments, possibly limited to a single type of restoration and repeat treatments at a number of sites. The CRC for Catchment Hydrology and the CRC for Freshwater Ecology have been undertaking such an experiment in the Granite Creeks Project (CRC for Catchment Hydrology Project 6.3). The advantage of a dedicated experiment is the ability to make inferences based on the experimental results and that some confidence can be placed in these inferences.

A limitation of the dedicated experimental approach is that, in order to achieve reasonable statistical power, the range of site types and methods of habitat reconstruction will necessarily be limited and monitoring costs may be quite high. In an extreme case, a dedicated experiment may be viewed as irrelevant by management agencies, which often carry out very complex projects at sites with a broad range of histories and with only limited resources. To address this limitation, we suggested that the experiments, undertaken by the MDBC, be carried out in parallel with more complex adaptive management projects. The dedicated experiment would inform the adaptive management project and the adaptive management project would extend the lessons of the dedicated project and encourage adoption of improved methods within management agencies.

*Project Reporting*

A report on the project 6.1 is being prepared for release before the end of the year. For more information about this project contact Ian Rutherfurd (idruth@unimelb.edu.au), Mike Stewardson (mjstew@unimelb.edu.au) or Tony Ladson (tony.ladson@eng.monash.edu.au).

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PROGRAM 7

## COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

### The Flow on Effect – October 2002

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

**This month's column is another of my regular overviews of 'adoption oriented' new publications, information and activities that may be of value to *Catchword* readers, particularly those interested in our Climate Variability and Urban Stormwater Quality Research Programs.**

*On the Calibration of Australian Weather Radars – CRC Technical Report 02/7*

Weather radar offers an enormous potential to improve the quality of rainfall measurement. This potential can translate into benefits in many sectors of the water industry ranging from improved design information, decisions on water allocation and management, through to improved weather and flood forecasts for greater public safety. A key step in transforming weather radar observations into accurate rainfall estimates however is the calibration of the weather radar data. This involves converting the quantity actually observed by the radar (known as reflectivity) into an estimate of rainfall intensity. The current approach used widely with Australian weather radars is to rely on a set of calibration factors that represent average, or climatological, conditions. This can lead to quite large errors in rainfall estimates.

The CRC Technical Report entitled 'On the Calibration of Australian Weather Radars' by Alan Seed, Lionel Siriwardena, Xudong Sun, Phillip Jordan and Jim Elliott describes investigations to improve the calibration process for weather radars in Melbourne, Sydney and Darwin. Raingauge data is used to analyse the likely errors in rainfall estimates from radar and calibration strategies to improve the quality of the radar rainfall estimates are proposed.

*Stochastic Generation of Monthly Rainfall Data – CRC Technical Report 02/8*

One of the goals of the Climate Variability Program in the CRC for Catchment Hydrology is to provide water managers and researchers with computer programs to generate stochastic climate data. The stochastic data are needed at time scales from less than one hour to a year, and for point sites to large catchments such as the Murrumbidgee and Fitzroy.

The first report in this series, 'Stochastic Generation of Climate Data: A Review' (CRC Technical Report 00/16), reviewed methods of stochastic generation of climate data and recommended the testing of a number of techniques. The second report, 'Stochastic Generation of Annual Rainfall Data' (CRC Technical Report 02/6), compared the first order autoregressive and hidden state Markov models for the generation of annual rainfall data. This third report, 'Stochastic Generation of Monthly Rainfall Data' by Sri Srikanthan, Tom McMahon and Ashish Sharma, tests the method of fragments and a non-parametric model for the generation of monthly rainfall data at ten sites across Australia.

*Stochastic Modelling of Daily Rainfall – CRC Working Document 02/5*

Stochastic generation of rainfall data offers an alternative to the use of observed records. The CRC Working Document 02/5 entitled 'Stochastic Modelling of Daily Rainfall' by Senlin Zhou, Ratnasingham Srikanthan and Tom McMahon presents an evaluation of daily rainfall generation models at 21 stations across Australia. The models evaluated were the Transition Probability Matrix (TPM) method, the Daily and Monthly Mixed (DMM) algorithm, and a variation of each model.

*Non-structural Stormwater Quality Best Management Practices - Guidelines for Monitoring and Evaluation – CRC Working Document 02/6*

In 2001 the CRC for Catchment Hydrology collaborated with the Victorian Environment Protection Authority to undertake research into the use and evaluation of non-structural best management practices (non-structural BMPs) to improve urban stormwater quality. Such BMPs include town planning controls, strategic planning and institutional controls, pollution prevention procedures, education and participation programs, and regulatory controls.

The primary aim of this research project was to produce monitoring protocols that could be used by local government authorities to measure the value and life-cycle cost of non-structural BMPs that improve urban stormwater quality. Over the next few months a series of four CRC Technical Reports by researcher André Taylor which address issues associated with Non-structural Stormwater Quality Best Management Practices will be published. Further information will be available in upcoming issues of *Catchword*.

A preliminary report 'Guidelines for Monitoring and Evaluation' (CRC Working Document 02/6) has been printed. It presents a new evaluation framework for measuring the effects and life-cycle costs of non-

## NEW TECHNICAL REPORT

### STOCHASTIC GENERATION OF MONTHLY RAINFALL DATA

**by**

**Ratnasingham Srikanthan**
**Tom McMahon**
**Ashish Sharma**

**Technical Report 02/8**

One of the goals of the Climate Variability Program in the CRC for Catchment Hydrology is to provide water managers and researchers with computer programs to generate stochastic climate data. The stochastic data are needed at time scales from less than one hour to a year and for point sites to large catchments like the Murrumbidgee and Fitzroy.

The first report in this series, 'Stochastic Generation of Climate Data: A Review' (CRC Technical Report 00/16), reviewed methods of stochastic generation of climate data and recommended the testing of a number of techniques. The second report, Stochastic Generation of Annual Rainfall Data' (CRC Technical Report 02/6), compared the first order autoregressive and hidden state Markov models for the generation of annual rainfall data. This third report, 'Stochastic Generation of Monthly rainfall Data', tests the method of fragments and a nonparametric model for the generation of monthly rainfall data at ten sites across Australia.

**Copies of this report are available through the Centre Office for $27.50 (includes GST, postage and handling).**

# WORKING DOCUMENT

## APPLICATION OF HIDDEN STATE MARKOV MODEL TO AUSTRALIAN ANNUAL RAINFALL DATA

by

**Ratnasingham Srikanthan**
**Mark Thyer**
**George Kuczera**
**Tom McMahon**

**Working Document 02/4**

In the past, the stochastic generation of annual data was performed generally with a first order autoregressive model which does not explicitly model the observed long periods of wet and dry periods in the annual data. Though geographers and geomorphologists have observed long cycles or changes in the mean level of rainfall and streamflow, it was not explicitly included in annual stochastic data models until the recent work of Thyer and Kuczera (1999, 2000). The model used is referred to as the hidden state Markov (HSM) model.

The purpose of this study is to apply the HSM model to annual rainfall data from a number of rainfall sites across Australia and identify the the sites where a two-state persistence structure was likely to exist.

**Copies are available through the Centre Office for $22.00.**

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. In addition, monitoring protocols and data recording sheets have been developed to support each style of evaluation.

*MUSIC Users Forum – 27 November 2002, Melbourne*
A MUSIC (Model for Urban Stormwater Improvement Conceptualisation) Users Forum will be held at Monash University on Wednesday 27 November 2002. The Forum will give users of the development version of MUSIC (Version 1.00) an opportunity to discuss their experiences in using MUSIC and to suggest enhancements for the next version.

All registered MUSIC users will receive a written invitation prior to the Forum. If you have any queries regarding this workshop please contact Peter Poelsma on 03 9905 4947 or email peter.poelsma@eng.monash.edu.au

*May 2002 Environmental Flows Workshop presentations online*
An Environmental Flows workshop convened by the Water Engineering Victorian Branch of the Institution of Engineers was held in conjunction with the Hydrology and Water Resources Symposium in Melbourne during May 2002. The workshop catalysed great interest from attendees and the speaker's presentations are now available as Adobe .pdf downloads from the CRC's news page at http://www.catchment.crc.org.au/news

For further information about the workshop and outcomes please contact Simon Robertson on 03 9614 6400 or by email srobertson@wbmpl.com.au

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**David Perry**
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# POSTGRADUATES AND THEIR PROJECTS

## Pandora Hope

I am doing my research in the School of Earth Sciences at The University of Melbourne, under the supervision of Ian Simmonds.

I started my career in the atmospheric sciences after finishing a science degree at Monash University, not really being sure what to do next. I was keen to earn some money and travel, but after six months attempting to find work and having no luck, (either too qualified, or not qualified enough), I decided to return to study.

Having a wide range of interests in science, I had majored in physiology and applied mathematics. Of the many topics covered in applied mathematics, I found dynamical meteorology to be the most interesting so I approached the mathematics department about doing honours. At Monash University, honours in applied mathematics is three-quarters course work, one quarter thesis. I did ten topics during my honours year, including all the meteorological and fluid dynamics courses offered. My favourite two topics were tropical cyclones and boundary layer meteorology.

After honours I continued to work for my supervisor, David Karoly, as a research assistant and extended my honours work. This was almost complete when he told me about a position at The University of Melbourne, to be a research assistant for Ian Simmonds. Ian Simmonds was interested in exploring land-surface processes and their interaction with the atmosphere, which I thought sounded great. I started work with Ian Simmonds in the School of Earth Sciences in 1994.

I initially started testing large scale drag parameterisations in the MUGCM, the Melbourne University General Circulation Model. This model applies the mathematical equations of the fluid dynamics in the atmosphere, along with parameterisations of many of the processes in the atmosphere and at the boundaries. These include a hydrological cycle with a simple surface layer scheme. The model is driven by prescribed sea surface temperatures, sea-ice and ice sheet extent, carbon dioxide and ozone levels and varying solar input. There is a full diurnal and seasonal cycle. The resolution of the MUGCM is approximately 5.5 x 3.3 degrees.

We then started an extended study on the persistence of atmospheric moisture conditions, and the influence exerted by the moisture content of the soil. The first step was to assess the persistence in Australia's rainfall records. From 79 years of data, there were instances of persistence beyond the level of chance, particularly after wet events. To assess the role of soil moisture on this persistence, it would have been ideal to use an Australia-wide dataset of soil moisture over the same period, but unfortunately this does not exist, although recent projects will help in the future. Thus we used the MUGCM to saturate or desiccate the surface and assess the response of factors in the climate system. Not surprisingly, the evaporation responded the most strongly. The precipitation response was weaker, and assymetric, with stronger memory after saturation.

Assessing how the surface in a certain region affects future precipitation in the same region raises the question of the source of the moisture. This led to a series of studies including using gridded moisture and wind data to derive the regions of moisture convergence across the globe. This data was also used to assess the flux of moisture along a wide path, thereby revealing source and sink regions. A 2-D and 3-D tracking scheme that uses data or model winds to follow a certain parcel from known precipitation events was then used to determine the general source region of parcels on that day. To extend this further to actual points of evaporation, transport and future precipitation, the MUGCM was used to track evaporating parcels from certain regions to their final point of precipitation. This is still work in progress.

Around this time I decided to further my education by embarking on my own research and doing a PhD. My interest was to include analysis with the MUGCM of various questions about the surface processes in Australia. My study ended up as an examination of the difference in the circulation and subsequent moisture regime in an extreme cool climate, including a comparison with paleo proxy data.

Paleo proxy data is generally from small-scale sites on the surface, so to compare them with results from a large-scale model, a degree of downscaling is required. This has taken the form of off-line modules to calculate variables that can be compared directly to the proxy data. One such module calculates the sand shifting potential and resultant direction of linear dunes, a common proxy for paleo circulations in Australia. This has required an in-depth understanding of atmospheric boundary layer physics and erosional processes. A second module is being developed to compare with indicators of wetness. Off-line modules require twenty years of six hourly global snapshots of the atmosphere. To store this requires a great deal of computer disk and storage space. Collaboration with the CRC for Catchment Hydrology has enabled me to undertake this style of research.

**Pandora Hope**
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# NEW WORKING DOCUMENT

## STOCHASTIC MODELLING OF DAILY RAINFALL

by
**Senlin Zhou**
**Ratnasingham Srikanthan**
**Tom McMahon**

**Working Document 02/5**

Stochastic generation of rainfall data offers an alternative to the use of observed records. This paper presents an evaluation of daily rainfall generation models at 21 stations across Australia. The models are the Transition Probability Matrix (TPM) method, the Daily and Monthly Mixed (DMM) algorithm, and a variation of each model.

A goal of stochastic modelling is to generate synthetic data that are representative of the statistical characteristics of the historical data. One hundred replicates of length equal to the historical data were generated using the above models. Preliminary assessment of the models suggests that overall both the TPM and DMM models preserved key statistical characteristics of the historical rainfall at the annual, monthly and daily levels. The DMM model was unable to preserve the amounts of rainfall on solitary wet days and the TPM model needed to be modified by the empirical adjustment factor to preserve the annual variability.

**Copies of this report are available through the Centre Office for $22.00 (includes GST, postage and handling).**

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# CRC PROFILE

## Our CRC Profile for October is:

### Tim Smith

Hello! I am Tim Smith and have recently taken over from Prof John Fien as Program Leader for Education and Training.

*Current Position*

I am based at Griffith University in Brisbane and my current workload is split between the Catchment Hydrology CRC and the Coastal CRC (where I am Theme Leader for Citizen Science and Education). The Program I lead in the Catchment Hydrology CRC includes social science research, postgraduate education and training, researcher professional development, and stakeholder education and training (delivered in conjunction with the Communication and Adoption Program led by David Perry). I also convene a Masters course in Environmental Decision-Making and supervise a few postgraduates through Griffith University. My dual role across the two CRCs allows me to enhance the activities of both CRCs.

*Career History*

My career path has taken a few interesting turns, with beginnings in an engineering consultancy (Patterson Britton and Partners – Sydney) and an Honours degree in nutrient geochemistry. I subsequently moved into the government sector, initially in local government as the waterways manager for Manly Council, and then into State government (NSW DLWC) to project manage the Stressed Rivers Assessment as part of the NSW Water Reforms. Through my work in government I began to realise that environmental management was actually about managing people and became interested in environmental management 'drivers' and management institutions. This led me to my PhD studies through UNSW (part-time), where I focussed on the management of Australian estuaries (institutional arrangements, management cultures, and community empowerment). My interest in this area was partly facilitated through a Land and Water Australia grant to develop a national framework for the management of Australian estuaries, which was published in February 2001. Since mid-2000 I have expanded my social science research through the Coastal CRC and have complemented my interest in education through a Graduate Certificate in Higher Education (in progress).

*Future*

I look forward to being involved in the CRC activities during this exciting time as we move into a new round of projects under the leadership of a new Director. I also look forward to the CRC delivering a much-needed integrated toolkit to the water industry. I would also like to thank James Whelan for his continued dedication to the CRC.

**Tim Smith**
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# WHERE ARE THEY NOW?

## Report by Vasantha Siriwardhena

### Where are they now?

After serving as the Chief Executive Office for a local consultancy firm in Sri Lanka for one year, I left that position mainly to obtain time to work more in the technical fields. I am currently serving as a senior environmental management consultant and planner for several leading local consultancy firms in Sri Lanka, mostly working for overseas funded projects. I work in the areas of groundwater and surface water quality management, environmental impact assessment and development of environmental management plans for infrastructure development projects, industrial pollution control and management, and institutional development programs.

My PhD program at RMIT, which was funded by the Melbourne Water Corporation and the CRC for Catchment Hydrology, has contributed immensely to the development of my technical skills and capacity in these fields. In particular, my ability with regard to the application of computer models and software packages in hydrologic data analysis and modelling has helped me to play a somewhat unique role in several projects, where such expertise is lacking in Sri Lanka. Also the painstaking time that I spent in writing the thesis has helped to develop my technical writing skills. In fact I have been commended on my reports and presentations. I believe my time spent in the research program with the CRC was worthwhile.

There are many consultancy opportunities developing in the water sector in the region. I consider that the CRC for Catchment Hydrology can also make use of these new opportunities. I am very happy that I did my PhD program in catchment hydrology. Let me thank the CRC for Catchment Hydrology, Melbourne Water Corporation, and in particular, my supervisors Dr Nira Jayasuriya and Dr Peter Hairsine, for their contribution towards my achievements.

**Vasantha Siriwardhena**
Email: est@wow.lk

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COOPERATIVE RESEARCH CENTRE FOR

CATCHMENT HYDROLOGY

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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 Land and Water Conservation, NSW
Department of Natural Resources and Environment, Vic
Goulburn-Murray Water
Griffith University
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