NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 115 APRIL 2003

A NOTE FROM THE DIRECTOR

Professor Rob Vertessy

THE PEOPLE BEHIND OUR CRC

In this issue of *Catchword*, I am motivated to talk about the human fabric of our CRC because two of our key staff are about to leave us to take on new challenges.

Peter Hairsine, one of our longest serving Program Leaders (1996-2003), will shortly stand down from his role as Leader of Program 2 (Land-use Impacts on Rivers) in order to focus on his new role as Leader of CSIRO Land and Water's new Integrated Catchment Management Research Directorate.

Peter will remain involved in project work with our CRC and will continue to lead many of the CSIRO staff who participate in our Centre, so we aren't losing him entirely. Nevertheless, it is an appropriate time to acknowledge Peter's tremendous contribution to our CRC as he will be stepping down from one of our most important management roles. His intellect and generosity of spirit have made a real impact on many of us, and I'm certain that I speak for many when I say we've been enriched by his comradeship.

Dan Figucio, our web guru extraordinaire, has given us five fantastic years of service but is now moving to the job of his dreams at Apple in Sydney.

Dan has created and maintained several impressive web sites for our CRC over the years and has used his expert graphic designs skills to make many of our papers, reports, posters and presentations look great.

Peter and Dan have been really valued colleagues and great mates and I wish them all the very best in their new roles.

CRCs are dynamic entities, owing to their continually evolving R&D agendas, and the considerable flux of staff and students in and out of operations. This dynamism is more acute in the CRC than in most organisations and is one of our great strengths; the continual injection of new people with new ideas keeps us challenged and maintains innovation.

It is pleasing to see people grow in our CRC and whilst we hate to see them leave, it is a buzz to see that they are coveted by the outside world for their skills. This is particularly so in the case of our many PhD graduates (some 80 in total thus far), most of whom are now rising stars in the land and water management industry. Fortunately for our CRC, we have several dedicated stalwarts to keep the corporate memory alive and to keep setting our sights over the horizon, where they should be. All organisations require some level of continuity to remain cohesive and focused, hallmarks of our own CRC.

Most of the staff and students of our CRC will have gathered in Yanco this month for our ninth Annual Workshop, affectionately referred to as the 'Love Camp'. These workshops are a keystone for our Centre; a forum to reflect on our achievements and aspirations, and to plot a collective course forward. They are vital glue too; many enduring collaborations and friendships have been forged at these gatherings. The Annual Workshop is certainly my highlight of the working year and I trust that this year's gathering at Yanco will have been every bit as stimulating and enjoyable as the last eight.

Rob Vertessy
Tel: (02) 6246 5790
Email: rob.vertessy@csiro.au

Inside...

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

CRC PROJECT PORTFOLIO (2003-2005)

The CRC has published a 'Project Portfolio' which gives readers an overview of the CRC, its mission and short summaries of all new CRC projects (2003-2005). A copy is included with this edition of Catchword.

Additional copies can be obtained from the Centre Office by contacting Virginia Verrelli on 03 9905 2704.

The document can also be downloaded as an Adobe Acrobat .pdf file from our website at www.catchment.crc.org.au/news

For further information please contact David Perry on 03 9905 9600.

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Report by Robert Argent

Building the whole-of-catchment prediction tool

Modelling modules

One of the main deliverables expected from the CRC for Catchment Hydrology in the next three years is the provision of a modelling capability to support the prediction of catchment behaviour. To this end all research programs are producing modelling "modules" or "tools" that will in some way be part of the Catchment Modelling Toolkit. The majority of these modules, such as tools for climate data generation, environmental flows assessment, or stormwater treatment, are designed to operate as a stand-alone tools that allow them to perform a specific function required by catchment researchers and managers. In addition, many of these modules are designed to form part of a larger, integrated whole-of-catchment modelling tool.

Integrated modelling tool

This article examines the development of the integrated modelling tool, and highlights the pieces of the modelling puzzle that will be produced as outputs from our research programs during 2003. The starting point for this is our current view of an integrated catchment modelling tool, typified by the EMSS. In the EMSS way of thinking, catchment processes are represented by NODE-LINK networks. NODES are identified as sources where, for example, nutrient loads from catchments are defined to enter the system. LINKS represent places where processing takes place, such as in storages, along channels or in estuaries (Figure 1.1). At a finer scale, LINKS could be used represent transport and processing from hillslope sources to streams.

In modelling catchment behaviour using an approach such as the EMSS, land uses represent sources of nutrients and sediment which enter the model at a NODE. These pollutants are then routed downstream along a LINK to arrive and enter as a source into a dam. The dam LINK then processes the pollutants (in time, if not in nature) and releases them as an input source to a downstream river LINK. This LINK may be used to apply processing to the pollutant in time, space and nature, with the resulting output passing as an input source to an estuary LINK.

The key to integrating the modules being produced by CRC for Catchment Hydrology research projects into this whole-of-catchment modelling picture lies in fitting the modules to the type of operation described above, and where things don't fit, changing either the module or the picture!

Putting the Pieces Together in 2003

- Products

  During 2003 we have a over twenty "products" coming into the Toolkit as outputs of previous (2000-2002) and current projects. Much of the work of Project 1B: 'Methods for integration in catchment prediction' (Activities 1 and 2) lies in determining if and how these outputs fit into the whole-of-catchment modelling capability, identifying any gaps between the outputs being delivered and the desired end point, and taking steps to fill those gaps. In the following paragraphs a description is given of how some of the 2003 products fit into the big picture, and how our whole-of-catchment modelling capability will look by the end of the year.

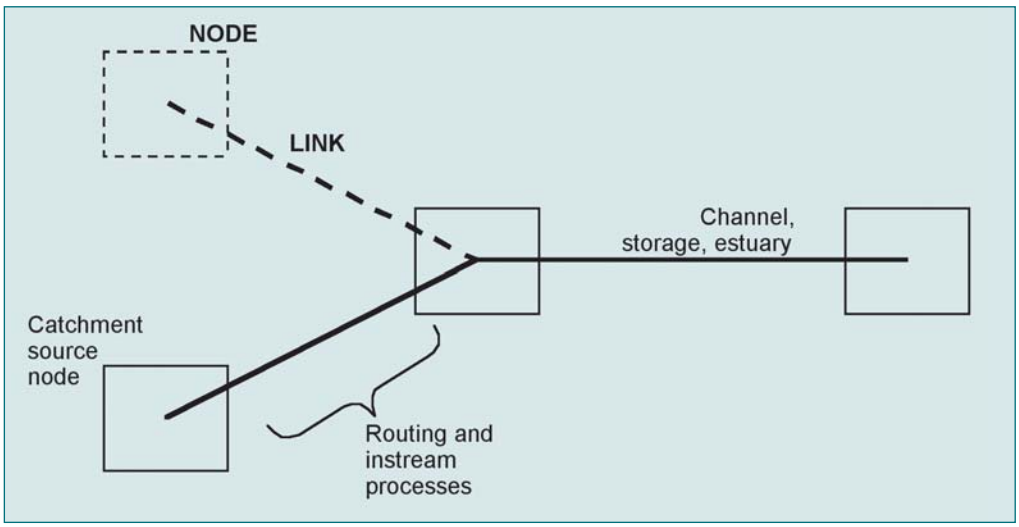


Figure 1.1 NODE-LINK networks

- Catchment drivers
  The overall drivers of the catchment system are the climatic influences, and the Toolkit's Stochastic Data Library, produced by Programs 5 and 1, can provide these. Spatial data on vegetation and soils, from Program 5, along with land-use information, will provide the basic catchment characteristics for pollutant modelling. Runoff from various parts of the catchment is generated by using a model selected from within the Rainfall-Runoff Library (Program 1). Constituent pollutants, such as salt, sediment and total and soluble nitrogen and phosphorus will be generated using modules developed from projects in Program 2, with Project 2D: 'Modelling and managing nitrogen in riparian zones to improve water quality' also contributing knowledge on the denitrification effects of riparian zones. In urban areas, Program 4 is providing data on urban stormwater quality, and modules to predict the change in quality under various treatment options.

- In-stream processes
  In-stream processing modules, from Programs 2 and 6, will allow simulation of floodplain deposition of sediment, bank erosion, pollutant processing, sand movement, as well as information on biologically relevant flow metrics. Program 1 is providing basic management modules such as storage behaviour and routing.

- Scenarios
  By the end of 2003, modelling to support management scenario exploration will include changes to flow duration curves under changing land uses (Program 2), as well as the required changes to rainfall-runoff model parameters to simulate these duration curve changes (Program 5). Temporary and permanent water market trading simulation, from Program 3, will provide information on changing land use in irrigation areas, leading to demand and supply changes, and possibly alternative flow patterns. Reach Analysis modules, from Program 6, will allow the ecological implications of alternative flow regimes to be investigated.

- Tools at hand
  Thus by the end of 2003 we will have a considerable array of tools in the Catchment Modelling Toolkit, with even more being added and tested over 2004 and 2005. Another role for Project 1B (Activity 3) is development and testing of our whole-of-catchment modelling capability, so look forward to some interesting investigations in that area.

Robert Argent
Tel: (03) 8344 7115
Email: r.argent@unimelb.edu.au

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

By Evan Christen and Mathew Bethune

Reducing the impacts of irrigation and drainage on river water salinity – Project 2A

Background

In any catchment that contains an irrigation land use, the impact of that irrigation on river water quality is invariably a topic of much debate. As such, the CRC has started Project 2A to assist in predicting the impact of irrigation as part of the Land-use Impacts on Rivers Program.

Surface drainage

Irrigation has impacts on river water quality both by affecting the volume and timing of flows in rivers, and in the drainage water that is returned to rivers. The first aspect is not being dealt with in this project but will be picked up in Project 3A: 'Hydrologic and economic modelling for water allocation' and the general toolkit approach. Project 2A deals with the returns to rivers from irrigated areas in the form of surface drainage.

Nature of irrigation run-off

Drainage water from irrigated areas is usually a mix of irrigation run-off, rainfall runoff, irrigation delivery escape flows, subsurface drainage flows, and other point sources such as domestic and agricultural industry wastewaters. In the simplest situation, irrigation runoff may leave an individual farm and make its way to a creek or river. In this situation the on-farm operations are critical with respect to the drainage water quality, and use of recycling systems - buffer storages and chemical management being typical factors. In the most complex situation, an individual farm is merely one of many sources of water that flow into a network of surface drains where the water can be diluted, abstracted, stored and undergo chemical transformation before eventually reaching the end of the system for discharge to a river, (see Figure 2.1).

Project aims

Project 2A aims to quantify farm/sub-catchment scale processes affecting drainage quality. Processes may include changes to irrigation management, climate variability, land use and management, surface and subsurface drainage, and irrigation water availability. Quantifying these processes will enable us to develop guidelines at the farm level to assist in minimising drainage and improving quality. From this level we want

FOREST MANAGEMENT WORKSHOP AND FIELD DAY - CANBERRA

RESCHEDULED FOR 9-11 DECEMBER 2003

The recently promoted Forest Management workshop arranged through a partnership between the University of New South Wales, NSW State Forests, the Forest Science Centre and the CRC for Catchment Hydrology has been rescheduled for the 9-11 December 2003.

Four major themes will be addressed during the first two days of this workshop:
- Forest Hydrology
- Sediment Delivery and Water Quality
- Fire Management
- Sustainable Forestry

On the third day participants will visit the burnt forest area at the western site of Canberra and plantation forestry sites of NSW State Forests near Tumut.

For further information regarding the workshop and how to register as a presenter or participant please contact David Perry on 03 9905 9600 or email david.perry@eng.monash.edu.au

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
web: www.awa.asn.au/bookshop/

NRE Information Centre
8 Nicholson Street (cnr Victoria Parade)
PO Box 500
East Melbourne
Victoria 3002 Australia
publication.sales@nre.vic.gov.au
Phone: 03 9637 8325
Fax: 03 9637 8150
www.nre.vic.gov.au
Open: 8.30-5.30, Monday to Friday

to develop a regional model that can predict management impacts on the quality of drainage from irrigated areas. This model is targeted for use by irrigation companies to assess short-term and long-term measures to improve water quality. In the first instance we will be working closely with the irrigation companies in the Shepparton and Coleambally Irrigation Areas. And of course, we will be developing something for the CRC Toolkit that will allow a simple description of irrigation as a land use in the whole-of-catchment context.

Project groups

This ambitious project is being led by CSIRO Land and Water from the Griffith laboratory with a major partnership with the Department of Sustainability & Environment at the Institute for Sustainable Irrigated Agriculture in Tatura. At this stage we are compiling all recent work and developing our conceptual frameworks for the modelling. These we will then discuss with our stakeholders in the Shepparton, Coleambally and Emerald irrigation areas through a series of workshops and meetings.

Evan Christen
Tel: (02) 6960 1586
Email: evan.christen@csiro.au

Mathew Bethune
Tel: (03) 5833 5243
Email: matthew.bethune@nre.vic.gov.au

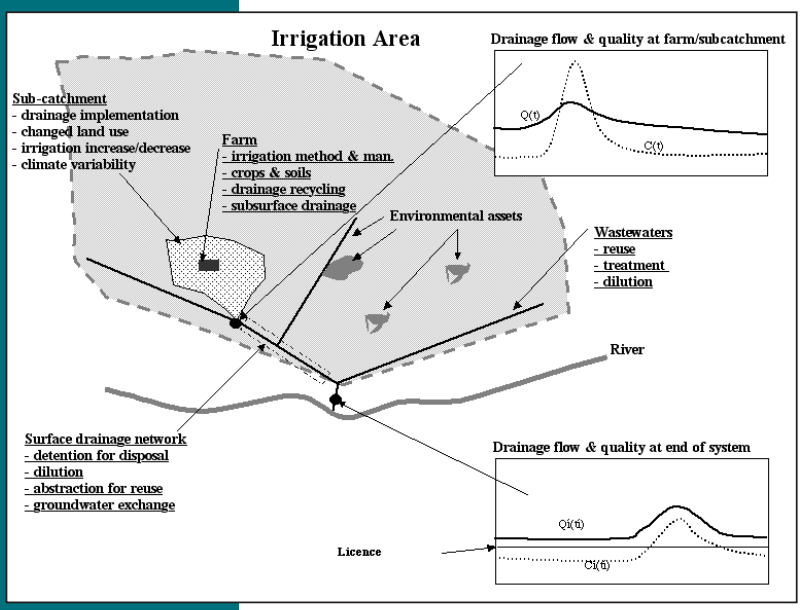


Fig 2.1 Schematic of drainage from farm to catchment scale in an irrigated area

PROGRAM 3
SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Mwater Workshop in Canberra

Background

As part of the communication and adoption strategy of Associated/Additional Project 3.4: "Enhancement of the water market reform process" (funded by Land and Water Australia as part of the National Program for Irrigation and Development) a small half-day workshop on Mwater was held on 28 March, 2003 in Canberra. Those in attendance included senior policy staff from ABARE, Environment Australia, MDBC and academics from ANU. The purpose of the workshop was to introduce Mwater and give participants an opportunity to be involved in a short series of simulations. A further workshop is planned to explore the application of Mwater to water policy evaluation.

Participant Feedback

At the end of the workshop, participants were given the opportunity to provide feedback though a short questionnaire prepared by CRC staff in Program 8. The feedback sheet included eight questions, four of which required a qualitative response and four requiring both qualitative and quantitative responses.

Q1 What were the best aspects of the workshop?

- Great to get a hands-on experience of the trade environment, rather than a demonstration, also to discuss issues and was a relief that it wasn't too technical/economics oriented for those without background
- Actually using the software, instructions were clear and it was interesting to observe our own personal reactions to the trading circumstances that arose
- The hands-on approach provided a real world aspect to policy application
- It gives the participant a feel about how the water market works or should work in real time, particularly with and without perfect knowledge
- Getting to work through the basic elements of a farmer's water trading decisions, rather than just reading about it – you get to learn so many more practical details that way
- Using the model significantly helps you gain an understanding of issues

Q2 Facilitation: Were you satisfied with the experience, knowledge and approach of the workshop facilitator?

Response	1	2	3	4	5	Mean
Frequency				2	5	4.71

- Yes, wish I have more opportunity to share some of his experience in other areas and his research
- Superb

Q3 Workshop content and structure: Did the two-day workshop cover suitable topics in an effective sequence? Were there adequate opportunities for interaction?

Response	1	2	3	4	5	Mean
Frequency				4	2	4.33

- Only positive criticism is that I would have liked more time, so we could get further into several months' trading to see how the market changes with the season

Q4 Application: To what extent do you consider this workshop will influence your approach to project management? How?

Response	1	2	3	4	5	Mean
Frequency			2	1	2	4

- Not exactly sure, but it has given me plenty to think about
- Provides a practical understanding of some of the issues surrounding water trading
- I have been involved in a number of modelling projects. This workshop taught us how to link an experimental economic component to help in outreach activities
- It will be invaluable experience in supervising a PhD student researching into water market trading, even if I don't directly get involved in market experiments again

Q5 Venue and catering: Did the venue and catering meet your expectations? Were you comfortable?

Response	1	2	3	4	5	Mean
Frequency				3	3	4.5

- Fine and very generous

Q6 Future workshops: What future workshops would you like to see the CRC offer?

- Look forward to the planned workshop in a month's time.
- Sessions where environmental or ecosystem services trade-offs are incorporated
- One on simultaneous trading in temporary and permanent water allocations, if such a development becomes available
- Similar workshops on your other research areas
- Target policy makers

Q7 How could the workshop have been improved?

- Would have been good to have more time to delve into some of the issues that affect the market operation (behavioural change of different scenarios would have been interesting)
- It was unfortunate that we didn't get to finish an entire cycle, some of the interesting aspects of trade and strategy were only just arising when we had to stop – was obviously just a time issue
- More time to assess the results
- Include a multicrop situation where MUP for a range of crops have to be consoled against the outside opportunity costs of crops
- More time for the actual experiment
- Clearer indication of policy questions to be addressed (beyond brand topics) ie. How can the model directly assist policy makers

Q8 Are there other things you would like to let us know?

- Would be a great experience for government policy advisers/officers/managers involved in water trading policy development
- This should be run as sessions for senior bureaucrats in all agencies involved in water policy
- It's great
- Great to see CRC money being put to such excellent use – thanks very much for a great free show

This feedback will assist in developing the next workshop.

John Tisdell
Tel: (07) 3875 5291
Email: j.tisdell@mailbox.gu.edu.au

DOWNLOAD CRC REPORTS

All of the CRC's reports since 1999 can be downloaded from our website at www.catchment.crc.org.au/publications

You can use our search engine to find the exact report you are seeking or to list all of the reports available.

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - An Overview of their Use, Value, Cost and Evaluation

By

André Taylor
Tony Wong

Technical Report 02/11

This report presents an overview of a CRC project co-funded by EPA Victoria that investigated the use, value, life-cycle costs and evaluation of non-structural best management practices (BMPs) for improved urban stormwater quality and waterway health.

The report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Tim Fletcher & Chris Walsh

Impacts of urbanisation on stream ecosystems: insights and opportunities

Urbanisation impacts: knowns and unknowns

The impacts of urbanisation on receiving waters are well known: altered hydrology, channel erosion, habitat loss, water quality degradation, and reduced biodiversity. The physical impacts (hydrology, water quality, channel morphology) are much better understood than the biological (ecosystem composition and functioning). Past management of urban stormwater tended to focus on a single objective – that of providing efficient drainage. More recently, a multiple objective approach has been adopted, attempting to integrate drainage and 'environmental' requirements. Managing for environmental objectives, however, requires an understanding of the complex and confounded processes (hydrology, water quality, habitat, etc) which impact on stream ecosystems.

In reality, waterway and stormwater managers rely on two surrogates of ecosystem impacts: flow and water quality. Tools such as MUSIC (Model for Urban Stormwater Improvement Conceptualisation) allow managers to develop stormwater management plans, aimed primarily at achieving certain water quality outcomes. For example, most Australian States and Territories apply water quality standards (e.g. ANZECC & ARMCANZ, 1999), in an attempt to protect receiving water ecosystems. However, it is not known whether meeting these water quality standards will maintain pre-disturbance ecosystem diversity and processes. For example, which water quality parameters are critical in determining ecosystem 'health'? Is it one, or many? How important is flow relative to water quality? Consequently, there is a need to better understand the impacts of urbanisation on stream ecosystems – and to relate that understanding to existing knowledge of flow and water quality impacts.

Urbanisation and the functioning of streams: a collaborative study

A large multi-disciplinary project has been undertaken by the CRC for Freshwater Ecology and the CRC for Catchment Hydrology, to address this need. The aim of the project was to develop relationships between catchment-scale indicators of urbanisation, and ecosystem functioning. Two primary catchment-scale indicators were used: imperviousness and drainage connection.

- Imperviousness and connection

  Imperviousness is simply the proportion of catchment area made up of impervious surfaces (roads, roofs, footpaths, carparks, etc). Impervious area has previously been demonstrated to be strongly correlated with degradation of stream ecosystems (Arnold & Gibbons, 1996; Booth *et al.*, 2002; Booth & Jackson, 1997; Schueler & Claytor, 1997). However, the degree and nature of drainage connection between this impervious area and receiving waters is also likely to be important, as it will determine the delivery efficiency of both flow and pollutants (Chiew & McMahon, 1999; Walsh, Sim and Yoo, 2002; Wong *et al.*, 2000).

  For the purposes of this study, connection is defined simply as the proportion of impervious area which is directly connected to receiving waters via pipe or hydraulically efficient channels.

- Site selection and methods

  Sixteen study catchments in the eastern fringe of Melbourne were selected, spanning a range of imperviousness and drainage connection (Figure 4.1). This allowed for the effect of imperviousness and drainage connection (both independently and jointly) to be examined (Walsh & Grace, 2002). Other specific indicators of the nature of urban land use (the densities of septic tanks and unsealed roads) were also measured for each sub-catchment.

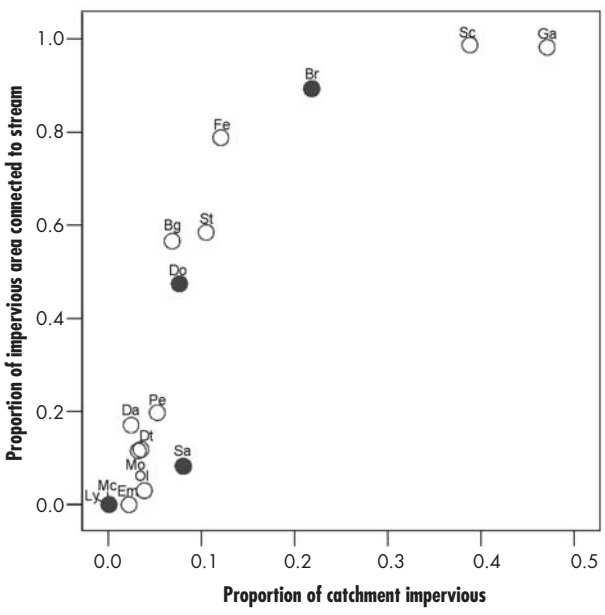


Figure 4. 1. Distribution of imperviousness and connection in 16 study sub-catchments (Walsh & Grace, 2002).

A number of measures of ecosystem health were examined at each of the 16 sub-catchments:

1. Pollutant transport and behaviour (nutrients, suspended sediment, electrical conductivity, dissolved organic carbon, some metals, temperature),
2. Production and respiration rates,
3. Benthic algal biomass,
4. Diatom and macroinvertebrate community composition.

Study findings

The findings for each component of the study were remarkably consistent: whilst both imperviousness and drainage connection were found to significantly influence ecosystem function, it was drainage connection which best explained stream degradation. Variation in most ecological condition variables was well explained by the four indicators of urban land use. The variance explained by the four indicators can be partitioned into that explained independently by each indicator, and that which is explained jointly by virtue of their being correlated with each other. (Figure 4.2). For most indicators of ecological condition, such as phosphorus and macroinvertebrate composition illustrated in Figure 4.2, although there was a large amount of variation explained jointly by the four indicators, connection had the strongest independent effect.

What does all this mean?

There is frequent reference to a '10% rule' in urban stormwater management; above 10% impervious area, major degradation to receiving water ecosystems can be expected (Beach, 2001; Schueler, 1994). The research undertaken in this study suggests that the '10% rule' is a potentially dangerous simplification. With the advent of Water Sensitive Urban Design, it is possible to significantly reduce the degree of connection between impervious areas and receiving waters (Figure 4.3). Through the use of swales, bioretention systems and wetlands, it may be possible to sustain higher levels of imperviousness (ie. urban development), thus reducing the need for urban sprawl.

Figure 4.3. Water Sensitive Urban Design reduces the connection of impervious areas to receiving waters, thus minimising impacts on stream ecosystems.

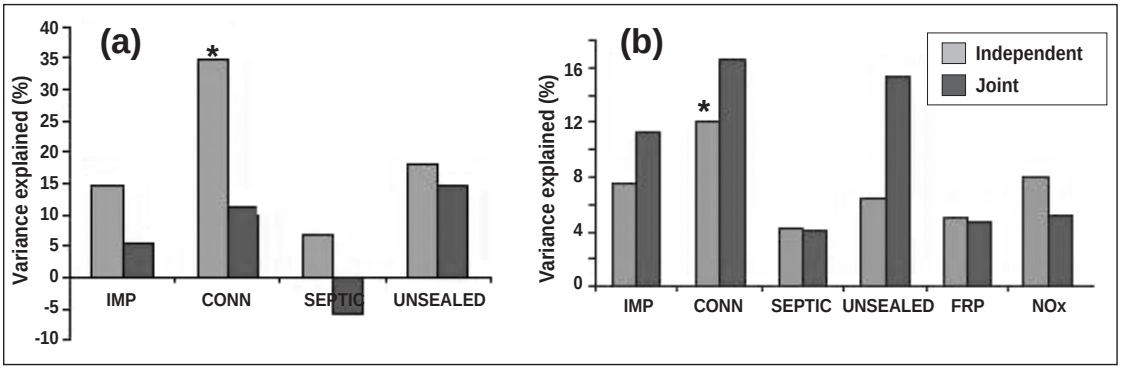


Figure 4.2. Proportion of variance in (a) phosphorus and (b) macroinvertebrate community composition, explained by catchment imperviousness (IMP), drainage connection (CONN), septic tank density (SEPTIC) and unsealed road density (UNSEALED). FRP = filterable reactive phosphorus, NOx = nitrate + nitrite. Asterisk an independent contribution stronger than might be expected by chance at p=0.05 (Hatt & Fletcher, 2002; Tsyrlin et al., 2002).

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - A Survey Investigating their Use and Value

By

André Taylor
Tony Wong

Technical Report 02/12

This CRC publication is one of four reports in a series of reports on Non-structural Stormwater Quality Best Management Practices. This report documents and analyses the findings of a detailed survey of 36 Urban Stormwater Managers from Australia, New Zealand and the United States.

A printed and bound copy of the report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - A Literature Review of their Value and Life-cycle Costs

By

André Taylor
Tony Wong

Technical Report 02/13

This CRC publication is one of four reports in a series of reports on Non-structural Stormwater Quality Best Management Practices. This report presents the findings of a literature review on the value and life-cycle costs of non-structural BMPs to improve urban stormwater quality.

A printed and bound copy of the report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

Predicting ecological outcomes

Collaboration between the CRC for Freshwater Ecology and the CRC for Catchment Hydrology continues in this area, with the aim of producing an 'ecosystem response module' for MUSIC, building on the research undertaken to date. The ultimate aim is that waterway managers will actually be able to predict the ecological outcomes of their stormwater management plans, in addition to the flow and water quality outcomes.

References

ANZECC, & ARMCANZ. (1999). *Draft Australian Water Quality Guidelines for Fresh and Marine Waters.* Canberra: Australian and New Zealand Environment and Conservation Council.

Arnold, C. L., Jr., & Gibbons, C. J. (1996). Impervious surface coverage: The emergence of a key environmental indicator. *Journal of the American Planning Association,* 62(2), 243-258.

Beach, D. (2001). *Coastal Sprawl. The Effects of Urban Design on Aquatic Ecosystems in the United States.* Arlington, Virginia: Pews Ocean Commission.

Booth, D. B., Hartley, D., & Jackson, R. (2002). Forest cover, impervious-surface area, and the mitigation of stormwater impacts. *Journal of the American Water Resources Association,* in press.

Booth, D. B., & Jackson, C. R. (1997). Urbanisation of aquatic systems - degradation thresholds, stormwater detention, and the limits of mitigation. *Journal of the American Water Resources Association,* 33(5), 1077-1090.

Chiew, F. H. S., & McMahon, T. A. (1999). Modelling runoff and diffuse pollution loads in urban areas. *Water Science & Technology,* 39(12), 241-248.

Hatt, B., & Fletcher, T. D. (2002, 29 September - 2 October). *Impacts of stormwater drainage and sewerage design on pollutant transport.* Paper presented at the 42nd Congress of the Australian Society for Limnology, Margaret River, W. A.

Schueler, T., & Claytor, R. (1997, August 4-9, 1996). *Impervious cover as a urban stream indicator and a watershed management tool.* Paper presented at the Effects of Watershed Development and Management on Aquatic Ecosystems. Proceedings of an Engineering Foundation Conference, Snowbird, Utah.

Schueler, T. R. (1994). The importance of imperviousness. *Watershed Protection Techniques,* 1(3), 100-111.

Tsyrlin, E., Walsh, C., & Newall, P. (2002). *Impacts of stormwater and other urban factors on macroinvertebrate & diatom community composition.* Paper presented at the 42nd Congress of the Australian Society for Limnology, Margaret River, WA.

Walsh, C. J., & Grace, M. (2002). *A conceptual model of stormwater impacts on stream ecological function and structure.* Paper presented at the 42nd Congress of the Australian Society for Limnology, Margaret River, WA.

Walsh, C. J., Sim, P. T., & Yoo, J. (2002). *Methods for the determination of catchment imperviousness and drainage connection* (Internal report for project D210). Melbourne: Cooperative Research Centre for Freshwater Ecology.

Wong, T., Breen, P., & Lloyd, S. (2000). *Water sensitive road design - Design options for improving stormwater quality of road runoff.* (Technical Report 00/1). Melbourne: Cooperative Research Centre for Catchment Hydrology.

Tim Fletcher
Tel: (03) 9905 2599
Email: tim.fletcher@eng.monash.edu.au

Chris Walsh
CRC for Freshwater Ecology
Tel: (03) 9905 4091
Email: chris.walsh@sci.monash.edu.au

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Geoff Pegram, Alan Seed, Sri Srikanthan & Francis Chiew

Modelling areal rainfall with pluviograph data

Introduction and Summary

Australia has a rich data bank of pluviograph (recording rain gauge) data around its major cities. The Bureau of Meteorology has conjunctive records of 20 or more pluviographs located within 150 km of Melbourne, Sydney and Brisbane reaching back more than 20 years. These may be augmented by data from networks maintained by other agencies. As a start, the Bureau's Melbourne Data set was analysed to see what models are appropriate.

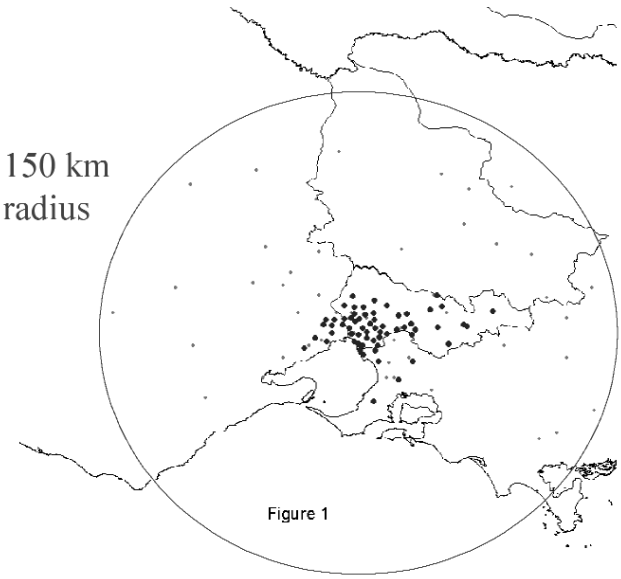


Figure 5.1. Location of pluviographs around Melbourne
(Small dots - BoM locations)
(Heavy dots – Melbourne Water)

This brief report indicates that an Alternating Renewal process model of exponentially distributed wet periods and Weibull distributed dry periods is appropriate for Melbourne data for all 12 months of the year. To validate the Alternating Renewal models, an alternative statistical model was employed - the derived sequence of wet and dry days modelled by a Markov chain.

It turns out that the Alternating Renewal models are good and that an appropriate daily Markov chain for the daily wet/dry process has a lag of two days, in common with many individual gauges modelled elsewhere in the world. Furthermore, a good theoretical link exists between the continuous and discrete models which may be exploited, after further development, to calibrate continuous models (including those based on radar) in places where there are only daily rainfall records. Figure 5.1 shows (by small dots) the location of the gauges used in this study (Melbourne Water gauges shown by the heavier dots are discussed further). Figure 5.2 shows one year of areal data and includes:

(i) the number of gauges concurrently recording together, and

(ii) the hourly mean areal rainfall rate.

Problem Statement

How was one to treat the pluviograph data to make inferences about the wet/dry periods over a large area (< 150km radius of Melbourne) with about 20 pluviographs active at any one time? The definition of thresholding was important: the wet period was to be at least 2 hours long, it was to contain no gaps greater than 4 hours, and had to accumulate an areal average of at least 0.2mm of rain. The month in which the spell started was defined as the "parent" month for the wet or dry spell. The next question was: How does one model the spells?

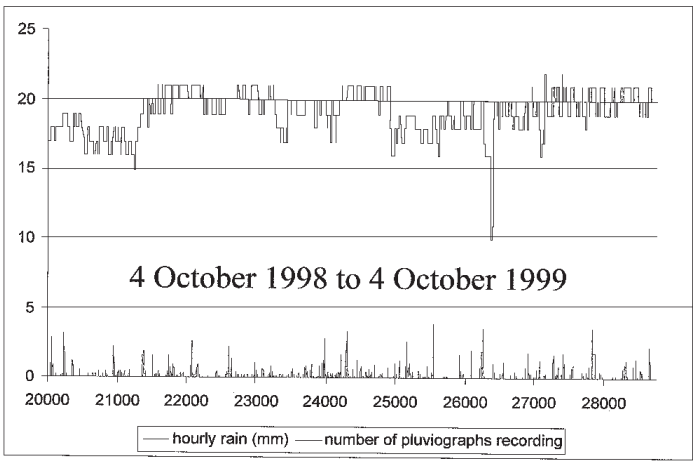


Figure 5.2. One year of areal data
Upper - number of operating pluviographs in any hour. Lower - hourly rainfall in mm - note the maximum areal depth is < 5 mm.

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management 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

NEW WORKING DOCUMENT

PREPARATION OF A CLIMATE DATA SET FOR THE MURRUMBIDGEE RIVER CATCHMENT FOR LAND SURFACE MODELLING EXPERIMENTS

by

Lionel Siriwardena
Francis Chiew
Harald Richter
Andrew Western

Working Document 03/1

This report describes the preparation of a climate data set for ten locations in the Murrumbidgee River Basin; Balranald, Hay, Griffith, Yanco, West Wyalong, Cootamundra, Kyeamba, Adelong, Canberra and Cooma.

The data will be used as forcing data for land surface modelling experiments. The locations coincide with the sites in the CRC's Murrumbidgee River Basin soil moisture monitoring program.

Printed and bound copies of this working document are available from the Centre Office for $22.00 (includes GST, postage and handling) or an Adobe .pdf file can be downloaded at www.catchment.crc.org.au/publications

Model Description

An obvious candidate model for the wet/dry process is the Alternating Renewal process (A-R) model. This, by definition, has independent increments, with an approximate exponential distribution. The first task was to check for sequential independence; the second task, to fit appropriate distributions.

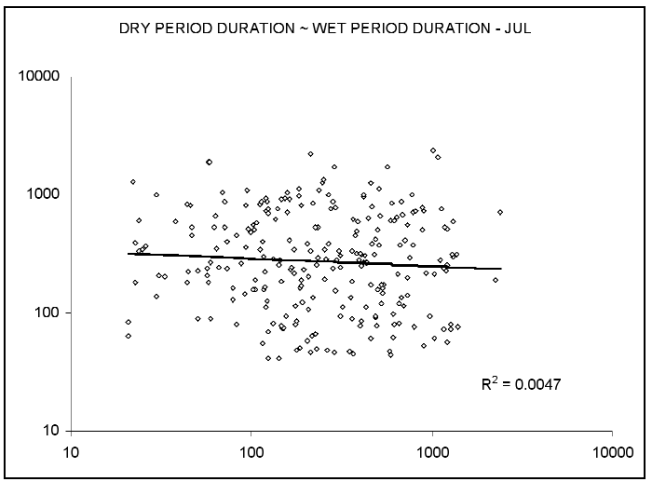


Figure 5.3. Dry spells ~ wet spells – July

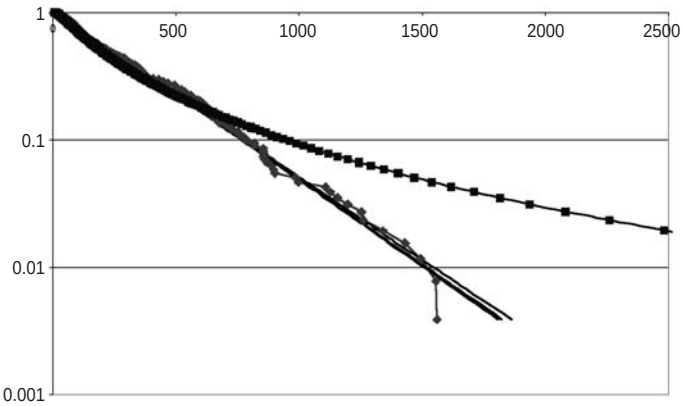


Figure 5.4a. Exceedence distributions Wet spell
Legend: Upper line with square symbols: lognormal. Lower (broken) line with diamonds: observations. Smooth lines: upper, exponential, then gamma and Weibull.

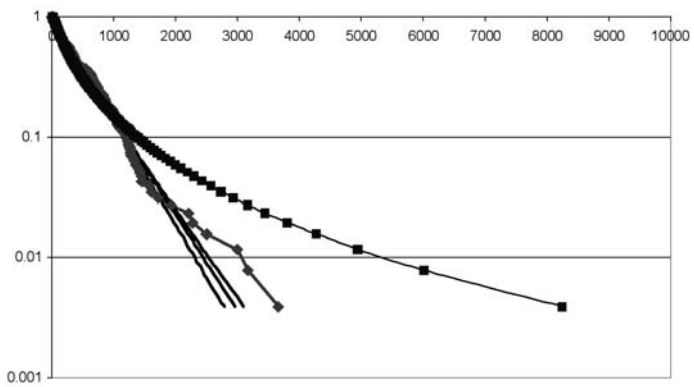


Figure 5 4b. Exceedence distributions Dry spell.
Legend: Upper line with square symbols: lognormal. Lower (broken) line with diamonds: observations. Smooth lines: upper, Weibull, then gamma and exponential.

It turned out that the sequences were essentially uncorrelated as can be seen in Figure 5.3 where dry spells are plotted against their following wet spells for the month of July. This plot is typical of the remaining months of the year and exhibits negligible structural correlation (R^2=0.0047). Figure 5.4a shows the candidate exceedence probability distributions (exponential, gamma, Weibull and lognormal – the last included in case a heavier tail was required) plotted coaxially with the observed wet spell data for September. The companion Figure 5.4b shows the same treatment for the dry spells for the month of September.

The "best" of the four candidate models was selected using the Akaike Information Criterion in its corrected form (AIC_c) (Hurvich and Tsai, 1989) which penalises the likelihood function by the number of parameters used in the model. It turns out that wet spells are modelled by exponential distributions in 11 out of 12 months, while dry spells are best modelled by the Weibull distribution with an exponent which has a mean for all months of 0.88. This exponent value is quite close to 1.0, which would turn it into an exponential distribution.

Validating the Model

Validation is different from verification which, in turn, is the activity for ensuring that what goes into a model comes out. Validation requires a check by some statistic not prescribed in the model. An appropriate one here is the sequence of wet and dry days derived from the observed and continuous wet/dry A-R process and modelled by a Markov chain (MC) with possibly multiple lags.

Again using the AICc to select the appropriate model for both observed and simulated A-R processes following Pegram (1980) it turns out that of the 12 monthly observed sequences (concatenated over the years because the spells are independent), 8 were modelled by a lag-2 MC while the remainder were lag-1. By contrast, the simulated sequences (100 years rather than the observed 30) of wet/dry days were exclusively modelled by lag-2 MCs.

Experimentation with the distribution defining the A-R models of wet/dry sequences showed that when both wet and dry spells were modelled by exponential distributions, the following conditional probabilities were equal:

$P_{0|00}$ = P[today is dry| yesterday and the day before were dry]

$P_{0|01}$ = P[today is dry| yesterday was dry and the day before was wet]

so both equal the equivalent lag-1:

$P_{0|0}$ = P[today is dry| yesterday was dry].

This is not so for the wet probabilities, so the chain is actually lag-2. This can be seen from Figure 5.5a which shows a plot of the transition probabilities to a current wet day for a lag-2 chain derived by simulation using exponentially distributed dry spells. Figure 5.5b shows a plot of the same transition probabilities when the dry spells are modelled by a Weibull distribution – note that the dry-dry probabilities are no longer equal.

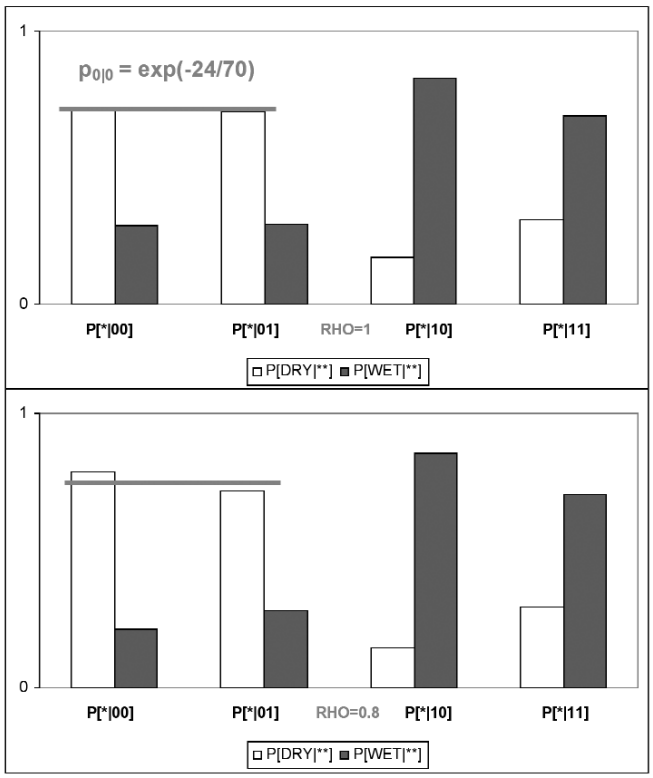
For validation purposes we compare plots of lag-2 MC transition probabilities to a wet day for both observed and simulated sequences in Figures 5.6a and 5.6b. This comparison shows that the validation test has been passed by the modelling procedure as the derived daily correlation structure has been maintained by the A-R model.

Links between A-R and MC Models

Small and Morgan (1986) forged the theoretical link between an alternating renewal wet/dry process with Gamma distributed dry periods and its derived daily lag-1 MC probabilities. Among other relationships, they derived the following, which applies if the Gamma is specialised to an exponential distribution for the dry periods:

$P_{0|0}$
= P[today is dry| yesterday was dry]
= $\exp(-T/\delta)$
which inverted becomes:
$\delta = -T/\ln(P_{0|0})$

where T is the period of integration (24 hours for a day) and δ is the mean dry period. This relationship was used to



Figures 5.5a & 5.5b. Lag-2 Markov chain transition probabilities computed from 1200 pairs of wet/dry spells distributed as (a) exponential dry (mean 70 hours) and wet (mean 30 hours); (b) Weibull dry (mean 70 hours, exponent 0.8) and exponential wet (mean 30 hours). The horizontal line indicates the theoretical values for the exponential model computed from Small & Morgan (1986).

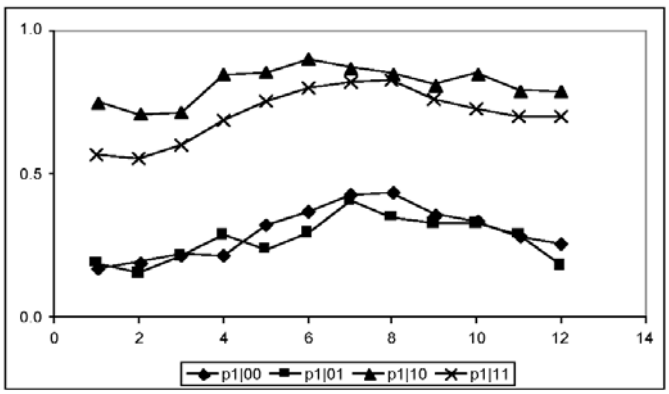


Figure 5.6a. lag-2 MC transition probabilities to a wet day - observed sequences. Number of data used to calculate these were approximately: 150 for $P_{1|00}$; 110 for $P_{1|01}$; 110 for $P_{1|10}$; and 510 for $P_{1|11}$; with corresponding measurement standard errors of 0.035, 0.041, 0.041 and 0.019.

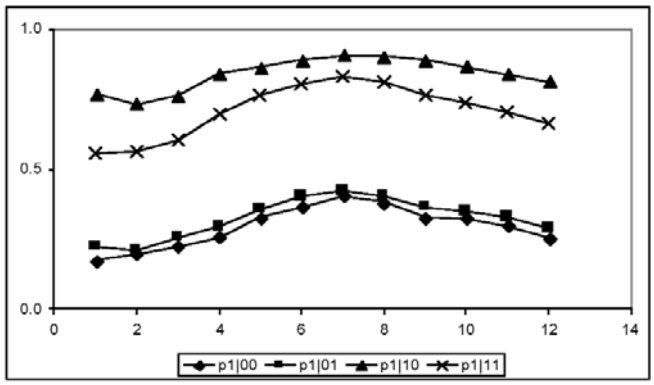


Figure 5.6b. lag-2 MC transition probabilities to a wet day - simulated sequences. Number of data used to calculate these were approximately: 450 for $P_{1|00}$; 330 for $P_{1|01}$; 330 for $P_{1|10}$ and 1530 for $P_{1|11}$; with corresponding measurement standard errors of 0.020, 0.024, 0.024 and 0.011.

NEW WORKING DOCUMENT

THIN PLATE SMOOTHING SPLINE INTERPOLATION OF PARAMETERS OF THE AR(1) ANNUAL RAINFALL MODEL ACROSS THE AUSTRALIAN CONTINENT

by

Penny Hancock
Michael Hutchinson

Working Document 02/7

A first order autoregressive, or AR(1), model was found by Srikanthan and McMahon to be appropriate for simulating annual rainfall amounts at a given location. The objective of this project was to develop thin plate smoothing surfaces that spatially interpolate the parameters of the AR(1) model across the Australian continent.

The study considered AR(1) parameters including the mean, the standard deviation, the skewness coefficient and the lag one autocorrelation coefficient.

Printed and bound copies of this working document are available from the Centre Office for $22.00 (includes GST, postage and handling) or an Adobe .pdf file can be downloaded at www.catchment.crc.org.au/publications

obtain the horizontal line in Figure 5.5a. We derived the equivalent formulation for $P_{0|0}$ for Weibull distributed dry spells but it is not available in close form, only as a convolution integral; T is no longer 24 hours in the Weibull case.

When we plotted this Weibull formulation against the observed data, the result was remarkable, as can be seen in Figure 5.7. The implication is that the A-R model parameters can be derived directly from the daily rainfall data as suggested by Small and Morgan (1986). This will have far reaching modeling implications for applying radar based models such as the string of beads model (Pegram and Clothier, 2001) which was the subject of a CRC preliminary study in 2002.

Conclusions

The rich collection of pluviograph data in Australia can be exploited to extract information to build "continuous" areal rainfall models and build the link between daily and continuous processes so that these models can be applied where only daily rainfall data are available. The preliminary results are very encouraging and work continues in this promising area of research.

References

Hurvich and Tsai, (1989). Regression and Time Series Model Selection in Small Samples, *Biometrika*, vol 76, no 2, pp 297-307.

Pegram, GGS, (1980). An Auto-regressive Model for Multi-lag Markov Chains, *Journal of Applied Probability*, vol 17, pp 350-362.

Pegram, GGS and AN Clothier, (2001). High resolution space-time modelling of rainfall: the "String of Beads" model. *Journal of Hydrology* vol 241, nos 1-2, pp 26-41.

Small, MJ and DJ Morgan, (1986). The relationship between a continuous-time renewal model and a discrete Markov chain model of precipitation occurrence, *Water Resources Research*, vol 22, no 10, pp 1422-1430.

Geoff Pegram
Tel: +27 31 260 3057
Email: pegram@nu.ac.za

Alan Seed
Tel: (03) 9669 4591
Email: a.seed@bom.gov.au

Sri Srikanthan
Tel: (03) 9669 4513
Email: sri@bom.gov.au

Francis Chiew
Tel: (03) 8344 6644
Email: fhsc@unimelb.edu.au

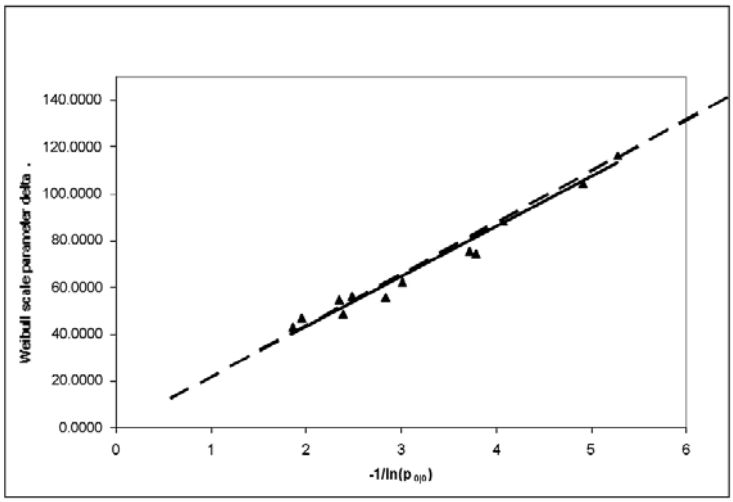


Figure 5.7. Weibull dry spell scale parameter δ plotted against -1/ln(P0|0). Triangles are the 12 monthly observed values from the fitted distributions of the dry spells and the estimated MC transition probabilities. The solid line is the trend line through the data. The dashed line is computed from a relationship (not given here) between δ and P0|0 for Weibull distributed dry spells with an exponent 0.88. The slopes of the lines are close to 22, rather than the 24 expected for exponentially distributed dry spells.

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

PROGRAM 6
RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Ciaran Harman and Michael Stewardson

The use of tributary data for "smart" environmental flow release rules at Thomson Dam

Background

Program 6, with support from EarthTech Pty. Ltd., has recently completed an investigation of the advantages of using real-time tributary data as a trigger for environmental flow releases from dams. Few studies have tackled the issue of how best to operate water schemes to meet environmental flow targets efficiently.

The purpose of this investigation was to develop a method for:

- estimating the total volume of dam releases required to meet downstream environmental flow targets efficiently, and
- assisting dam operators to meet the flow targets by providing a simple set of operating rules.

Thomson Dam Case Study

The investigation dealt with the case study of releases from Thomson Dam on the Thomson River in Gippsland, Victoria. The method is applied to environmental flow targets at one reach, which comprise both baseflows – which are the minimum flow levels to be met at throughout the year – and seasonal pulses of particular magnitude, frequency, duration. The case study used the reach of the Thomson River between the Aberfeldy confluence and the downstream Cowwarr Weir.

The method (described in a CRC for Catchment Hydrology report to be published later this year) uses flows in an unregulated, gauged tributary (in this case the Aberfeldy River) to trigger release events at the dam.

Benefits of using tributary flows

The use of tributary flows as a trigger has three principal benefits:

- Dam releases can be supplemented with inflows from the tributary to meet targets downstream of the tributary confluence. This 'piggy-backing' reduces the total volume of water required for environmental flow releases.
- Environmental flow releases will tend to be less frequent in drought years and more frequent in wet years. In some schemes this will result in an increased security of supply.
- Natural inter- and intra-annual variability is introduced to the flow regime.

Dam release model

A model was developed to examine the flows at the compliance point under different dam release regimes. This model generated a time series of dam releases based on a particular set of operating rules, a simple routing model, and a time-series analysis module.

Comparison of releases with operating rules

We compared "smart" operating rules (which make use of tributary inflows) and "dumb" operating rules which assume environmental flow requirements have to be met entirely by dam releases. The "smart" rules used tributary inflows as a trigger for pulse environmental flow release and reduced the magnitude of releases in proportion to the tributary inflow.

Baseflow water releases were more than 50% lower with the "smart" rules. The "dumb" rule set released baseflow from the dam at the rate required at the compliance point by the flow targets. In general this resulted in flows far in excess of that required at the compliance point due to inflows from the Aberfeldy and from ungauged tributaries. Significant reductions were observed in the volume of water released for baseflow under the optimised rule regime, with negligible drop in compliance with the requirements. Baseflow targets were reached on 97% of the days.

Optimum rules

Using 1600 simulations, we identified the optimum set of "smart" rules for meeting the environmental pulse flows required for this reach. The "smart" rules provided water savings of 35% and 75% for the required summer and winter pulse events respectively. No single set of rule parameter combinations produced this optimum, but rather a range of combinations all produced similar savings. These different combinations represent different strategies for meeting the targets.

HYDROLOGIC IMPACTS OF BUSHFIRES WEBSITE

In response to many requests for information about the hydrologic impacts of the recent bushfires, the CRC has established a website to deliver relevant information to catchment and water supply managers.

The site is a modest resource at this point and will evolve as more contributions are made. The site initially features a FAQ section designed for land and water managers, an overview of the hydrologic impacts of fire, a news page for information about related activities and reference lists that will be of particular interest.

The site can be found at www.catchment.crc.org.au/bushfires

The CRC welcomes contributions from all individuals and organisations to the site to expand its value to land and water managers.

If you can contribute to this site please contact david.perry@eng.monash.edu.au

Conclusions so far

This initial case study has shown that the method presented can estimate the volume of water required to meet targets in a single reach under a practical set of operating rules. The extension of this technique to provide a set of rules that meet the targets of multiple downstream reaches is a complex task, but one that will provide a complete estimate of the resource required to meet the flow targets, as well as a set of rules that may be used by dam managers.

Variations of this method may increase its performance and reliability. Other environmental factors may be considered as triggers for event releases, either instead of, or in conjunction with, tributary flows. The most obvious of these is rainfall. This may risk over-complicating the rule system, but may also improve its reliability in the long term. Whilst the investigation dealt with a case study, the methods are generally applicable to rivers regulated through operation of dam releases.

For water schemes more complex than the Thomson Dam, additional detail will be required regarding operation of the water scheme, increasing the range of operating rules to be considered. However, the problem is essentially the same as that considered in the case study of the Thomson River between the Aberfeldy River confluence and Cowwarr Weir.

Ciaran Harman
Email: harmac02@cwr.uwa.edu.au

Michael Stewardson
Tel: (03) 8344 7733
Email: mjstew@unimelb.edu.au

NATIONAL CONFERENCE ON INTEGRATED CATCHMENT MANAGEMENT (ICaM - 2003)

26-27 November 2003 Parramatta, NSW

ICam - 2003 aims to bring together practising scientists, engineers, policy makers, community educators and academics in the field of environment and catchment management.

Case studies from around Australia are especially encouraged, providing delegates with opportunity to share their problems and solutions with the wider water resource community.

For further information about contributing papers or attending please email your query to icam2003@awa.asn.au

PROGRAM 7

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect April 2003

At a glance – a summary of this article

This month's article will give readers details of new reports that are available through the CRC Centre Office and our website.

Urban Stormwater Quality Report Series - Non-structural Stormwater Quality Best Management Practices

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.

André Taylor and Tony Wong have produced a series of four reports to communicate this work to stakeholders. These reports are being published by the CRC:

- CRC for Catchment Hydrology Technical Report 02/11 entitled 'Non-structural Stormwater Quality Best Management Practices - An Overview of their Use, Value, Cost and Evaluation'. This report describes the project's aims, background, methodology, and presents key findings in a condensed form. The report is available now through the Centre Office.
- CRC for Catchment Hydrology Technical Report 02/12 entitled 'Non-structural Stormwater Quality Best Management Practices - A Survey investigating their Use and Value' reports on the findings of a detailed survey of 36 urban stormwater managers.
- CRC for Catchment Hydrology Technical Report 02/13 entitled 'Non-structural Stormwater Quality Best Management Practices - A Literature Review of their Value and Life-cycle Costs' presents the findings of a literature review on the value and life-cycle costs of non-structural BMPs to improve urban stormwater quality.
- A report on monitoring and evaluating non-structural BMPs for urban stormwater quality improvement. A draft version of this report has been released as a working document (CRC Working Document 02/6) and is available through the Centre Office and from the CRC website. The report presents guidelines and 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. This work will be published as a CRC technical report later this year.

Other publications

Water Trading in the Goulburn-Murray Irrigation Scheme – CRC Technical Report 02/9

CRC Project 3.1: 'Integration of water balance, climatic and economic models' aims to integrate hydrologic and economic modelling to examine the economic and environmental impacts of water allocation policies. This process comprises the selection and development of integrated modelling tools to support policy and management decision-making processes by water authorities.

As a supplement to Project 3.1, CRC for Catchment Hydrology Associated/Additional Project 3.6 involves the integration of hydrologic modelling with economic modelling to study the potential impacts of temporary and permanent trading in water entitlements on environmental flows in the major Victorian rivers. This technical report presents the findings of a survey of temporary and permanent water traders in Victoria designed to ascertain the main drivers of water trading and quantify their relative importance.

The findings of the survey also enabled the quantification of critical economic relations that form part of a comprehensive water demand model designed to complement the existing modelling framework used by Victorian water authorities. The modelling framework can play a vital role in predicting the potential environmental externalities resulting from expanding water markets.

This report is now available.

Thin Plate Smoothing Spline Interpolation of Parameters of the AR(1) Annual Rainfall Model Across The Australian Continent – CRC Working Document 02/7

A first order autoregressive, or AR(1), model was found by Sri Srikanthan and Tom McMahon to be appropriate for simulating annual rainfall amounts at a given

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 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.

location. This working document describing their research has now been published.

Preparation of a Climate Data Set for the Murrumbidgee River Catchment for Land Surface Modelling Experiments – CRC Working Document 03/1
This working document describes the preparation of a climate data set for ten locations in the Murrumbidgee River Basin; Balranald, Hay, Griffith, Yanco, West Wyalong, Cootamundra, Kyeamba, Adelong, Canberra and Cooma. The data will be used as forcing data for landsurface modelling experiments. The locations coincide with the sites in the CRC for Catchment Hydrology's Murrumbidgee River Basin soil moisture monitoring program.

The climate data comprised 30-minute time series of rainfall, air temperature, specific humidity, wind speed, wind direction, incoming shortwave radiation and incoming longwave radiation. To date, the data have been compiled for the period from January 2000 to June 2002. The data will be updated every six months. This working document is now available.

Obtaining CRC Publications
To obtain printed and bound copies of CRC reports and other publications please contact Virginia Verrelli at the Centre Office on 03 9905 52704 or by email to crcch@eng.monash.edu.au

Prices for the publications, which include GST, postage and handling are:

CRC Technical Report 02/9	$27.50
CRC Technical Report 02/11	$27.50
CRC Technical Report 02/12	$27.50
CRC Technical Report 02/13	$27.50
CRC Working Document 02/6	$22.00
CRC Working Document 02/7	$22.00
CRC Working Document 03/1	$22.00

To download Adobe Acrobat .pdf files of CRC reports please visit our publications database at http://www.catchment.crc.org.au/publications

David Perry
Tel: (03) 9905 9600
Fax: (03) 9905 5033
Email: david.perry@eng.monash.edu.au

POSTGRADUATES AND THEIR PROJECTS

Sarah Johnson

Hello, my name is Sarah Johnson and it's my turn to tell you a bit about myself and my involvement with the CRC for Catchment Hydrology as a postgraduate student.

Background:
Ever since I was a child I have had a strong interest in ecology and the environment. I remember growing up near the beach, spending hours peering into rock pools, being fascinated by all the creatures and critters I discovered. As an adult I maintained this keen interest in the environment, and began a Bachelor of Science at Monash University in 1997, focusing on aquatic ecology and environmental management. After my undergraduate studies I stayed on at Monash to complete my Honours year, studying the ecology of intertidal seagrasses in Westernport Bay, Victoria. It was during my Honours year that I began to realize how interconnected aquatic environmental issues were. The seagrass I was studying was being affected by the water quality of in-flowing streams, which were in turn being affected by land-use practices in their catchments, the management of which might span several management authorities. This experience really made it clear to me that aquatic environmental issues could not be studied in isolation from one another, as all to often the environmental issues in one area or ecosystem would have an impact on the quality of another.

Following my Honours year I spent a brief period seeking professional employment, before being offered a summer scholarship position with the Urban Stormwater Program at the CRC for Catchment Hydrology. During the summer of 2001/2002 I assisted with the research being conducted at Lynbrook Estate, looking at the effectiveness of structural stormwater treatment measures. At the completion of my summer position I was asked to stay on as a postgraduate student, and began my Masters in early 2002, under the supervision of Tim Fletcher and Chris Walsh, and later on Tony Ladson. My postgraduate studies with the CRC have in effect moved 'upstream' from my Honours research, in that I am now studying the effects of stormwater on urban stream ecologies.

My Project:
The focus of my research is on the effects of reduced water quality on macroinvertebrates in urban streams, as a result of increased stormwater inputs. For many

years now ecological research has strongly suggested that the input of stormwater to urban streams, a common management practice prevent flooding, has a negative effect on the ecology of urban streams. What appears to be lacking however, is a detailed understanding of the mechanisms of these effects. Such an understanding is needed if stormwater is to be managed in such a way as to minimise or prevent the potentially negative impacts of stormwater on the ecology of urban streams. In recent years there has furthermore been an increase in the value placed on the ecology of urban streams, therefore increasing the need for this type of stormwater management.

The effects of stormwater on the ecology of urban streams can be broadly broken up into two main factors: increases in flow related stress, such as increased stream velocity, scour and turbulence, and a decrease in water quality i.e. pollutants such as metals, oils and sediments, that are washed into urban streams with the stormwater. My project is specifically focusing on the effects of reduced water quality on macroinvertebrates in urban streams as a result of stormwater inputs. There is some research to suggest reduced water quality maybe having a greater impact than increased flow related stress on macroinvertebrates in urban streams. I am using macroinvertebrates as indicators of stormwater effects for several reasons, including their wide use as water quality indicators, their likely sensitivity 'catchment scale disturbances' such as stormwater, and their relative ease in use for experimental research.

The research I have carried out so far into the ecology and of biology of macroinvertebrates around Melbourne suggests that macroinvertebrates can be broadly broken up into those that are either sensitive or tolerant to increased flow related stress and/or reduced water quality. As both these effects occur simultaneously during stormwater inputs to urban streams, only macroinvertebrates that are tolerant to both these factors are likely to be found in urban streams with high stormwater inputs. Macroinvertebrates that are sensitive to increases in flow related stress and/or reduced water quality are thus likely to be absent from such streams. To begin with, am I looking at the effects of reduced water quality on macroinvertebrates that are likely to be tolerant to increased flow related stress, but sensitive to reduced water quality. This will be done by conducting laboratory experiments in which selected macroinvertebrates will be subjected to water harvested from an urban stream with high stormwater inputs. If my experiments show that these macroinvertebrates are negatively effected by reduced water quality, without the confounding effects of increased flow related stress, this will give us a better understanding of the mechanisms as to how stormwater affects these macroinvertebrates. Such an understanding will hopefully contribute to the ability of managers to make more informed decisions about the likely effects of stormwater on the ecology of urban streams, and thus lead to possible ways of mitigating and/or preventing such effects.

I am enjoying being part of the CRC for Catchment Hydrology, and the many opportunities available to me as a postgraduate student, such as being involved in research with strong industry links, participating in postgraduate workshops and working with groups such as the CRC for Freshwater Ecology and Melbourne Water. I believe that our multidisciplinary approach puts us in an excellent position to tackle the environmental issues facing us, both now and in the future. If anyone in interested in finding out more about my project please do not hesitate to contact me for more information.

Sarah Johnson
Tel: (03) 9905 5946
Email: sarah.johnson@eng.monash.edu.au

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
web: www.awa.asn.au/bookshop/

NRE Information Centre
8 Nicholson Street (cnr Victoria Parade)
PO Box 500
East Melbourne
Victoria 3002 Australia
publication.sales@nre.vic.gov.au
Phone: 03 9637 8325
Fax: 03 9637 8150
www.nre.vic.gov.au
Open: 8.30-5.30, Monday to Friday

CRC PROFILE

Our CRC Profile for April is:

Susan Daly

Current Position

Hi, my name is Susan Daly and I am a Graphic Designer here at the CRC (Centre Office, Monash). My role, as part of the Communication and Adoption Program, involves web and print design as well as contributing to the user interface design of the Catchment Modelling Toolkit product suite. My main project for this year will be designing the interface for the Catchment Modelling Toolkit web site and related marketing and communication materials as well as being part of the Toolkit Strategy Group. I will also be taking on a lot of the print work that was previously outsourced, such as publications, reports and various flyers.

Personal/Career History

I grew up in the southwest Victorian town of Ararat, 'the gateway to the Grampians'. Most of my spare time there was spent on friend's farming properties, playing netball and generally hanging out with my triplet brother and sister (yes! quite a handful for my parents) causing as much havoc around the Daly household as possible. My sister and I have both displayed a keen interest in drawing and anything creative as long as I can remember; throughout primary and high school we entered numerous competitions and were involved in several community art projects. As soon as I learnt what a Graphic Designer was, I knew that's what I wanted to become.

After High School finished I began my Arts Degree, majoring in Graphic Design, at the University of Ballarat. My parents decided to transfer their jobs and move to Ballarat due to the fact they were sending three of their children to University at the same time. So I was fortunate enough to have their support and of course the use of their car and a home cooked meal every night. The fact that we lived within a short walk to the campus was an added bonus!

After graduating, my first job as a Graphic Designer was with a small Advertising/Design firm in Ballarat: I think I learnt more in my first two weeks there than my three years at University. Our biggest client was Mars Confectionary, and I was lucky enough to play a large creative role in the concept and design of the packaging for the Mars Starburst range. As well as getting experience in designing print and packaging products, I got the chance to work on a couple of small web sites. Creating interactive pages and animation, even if it was only animated GIF's at that stage, was exciting to me and I quickly developed a strong interest in web design as a communication tool.

In order to follow my dream, I had to make the move to the big smoke and subsequently a position as a Graphic Designer for an online software development company in South Melbourne. This was an exciting and challenging role and provided me the opportunity to work alongside programmers and learn a lot about web design and the industry in general, which was booming at the time. My main focus here was being part of a team that developed the user interface for the company's product suite; the way it looks (GUI) and the way in which people interact with the software (usability). My role also involved designing the associated marketing and training tools for the products. I found this role challenging because the software products were targeted towards people in small businesses who often didn't have any technical knowledge in this area. Not only did the clients need to learn how to use the software, but they also needed to grasp the concept of using on-line software, which was a relatively new concept in itself. Educating these users proved to be a challenge in itself.

And then came the Dot Com crash ! This took myself, and a lot of other web designers by complete surprise and left most of us out of a job and wondering what to do next. Luckily I had a solid background in print design so I was able to find myself a job reasonably quickly. Unfortunately, there was no web design involved in my new position (I couldn't really afford to be picky either as the bills needed to be paid!), but it did rekindle my passion for layout and traditional design principles. It also helped me get up to speed on the latest technology and processes in the printing industry. The company's clients were mainly in the entertainment industry, so the perks were great; I found myself going along to plays and concerts quite frequently.

It didn't take long before I was itching to get back into web design, but by this stage I liked the idea of utilising both my web and print design experience, so the hunt was on for a job that incorporated both. Which brings me to my position at the CRC. My position here will provide me with opportunity to use the full breadth of my design skills in a large variety of applications.

As far as home life goes, I live in East Brighton with my partner, and two dependants; our Tonkinese cats Mocca and Coco. I still play netball during the week, mainly for exercise, and keep in close contact with family and friends from Ballarat and Ararat.

I view my role at the CRC as an exciting new challenge and environment for me, and I look forward to working with such a highly skilled and dedicated group of professionals. I would also like to take this opportunity to thank everybody who has assisted me in settling in to my new surrounds, and for making me feel welcome.

Susan Daly
Tel: (03) 9905 5580
Email: susan.daly@eng.monash.edu.au

WHERE ARE THEY NOW?

Report by Lindsay White

Fishways, smoke, drought, information, and misinformation

I finished my PhD thesis the day after a natural disaster: the January 2003 fires in Canberra. The last edits were made sitting in the gazebo at my new family home, with one eye on the monitor of a laptop, whilst the other was watching for blackened leaves that were still occasionally falling from the sky (to make sure they were not alight). Smoke, and the sounds of helicopters and fire trucks, were in the air.

In common with most PhDs, completing the thesis had been a consuming struggle for my family and myself. The struggle to finish the PhD suddenly seemed like a minor inconvenience in the context of the many Canberrans who had just lost their homes and many of their irreplaceable items.

On the day the fires struck Canberra, our suburb was briefly on the lengthy high alert list. Fires had spotted on hills within a few kilometres of home. The neighbours had told us that a neighbouring suburb was being completely evacuated due to the fire threat. This prompted filling our car boot with items that couldn't be left behind: including family photos and the laptop containing my thesis. Thankfully, the advice from the neighbour proved to be misinformation, which unfortunately was abundant at the time.

By now, 'where I am now' would be clear to readers. I am living in Canberra, and working with a CRC for Catchment Hydrology participant, the Murray-Darling Basin Commission, on a large water sharing initiative known as the Living Murray. Information on the Living Murray initiative is available on: www.thelivingmurray.mdbc.gov.au.

My job is to manage a small team producing information (hopefully little of which is proved in the future to be misinformation!) for decision makers (senior agency staff and Ministers) and the community. The current drought provides an interesting backdrop to a discussion on water sharing! My team is currently undertaking or managing studies on the topics of hydrological modelling, ecology, economics, and social science. Other work areas in the Living Murray include: the development of water 'recovery' policy options, community engagement, and structural and operational changes (including at least $10 million investment on fishways).

My PhD thesis was on fishways. It was titled 'Advancements in the engineering and scientific basis of fishways: with an emphasis on the Murray-Darling Basin, Australia'. The subject matter in the thesis was about 50% engineering and 50% fish biology. My fieldsites were at Torrumbarry and Yarrawonga weirs on the River Murray, where I would arrive with smoke almost streaming from the tyres after the hot six hour drives from my (then) home in Sale.

My PhD thesis will be a useful basis of fishways design guidelines for the Murray-Darling Basin. These guidelines, which are very timely given the above investment, are currently being prepared by Bob Keller (from the CRC for Catchment Hydrology).

I'm pleased to report that both biologists and engineers within the MDBC are fascinated by fishways, and committed to making them effective, and are willing to explore innovations. This is very positive.

For support of my research, I am very grateful to Bob Keller, and my other two supervisors [Ian Rutherfurd (CRC for Catchment Hydrology), and John Harris (CRC for Freshwater Ecology)]. I am also grateful to a number of individuals at Monash University, and participating agencies of the CRC for Catchment Hydrology. The Goulburn-Murray Water weirkeepers at Torrumbarry and Yarrawonga weirs deserve special mention.

I look forward to contact with members of the CRC for Catchment Hydrology and CRC for Freshwater Ecology in the future.

Thankfully, the smoke and helicopters are no longer in Canberra's air, and recent rain has created some hope of a decent 'autumn break' and the end of the drought. My favourite song during the long drives to my fieldsites featured the line 'after the flood, all of the colours came out' (U2 song, Beautiful Day). Maybe that is true after bushfires and drought also.

Lindsay White
Tel: (02) 6279 0103
Email: lindsay.white@mdbc.gov.au

WHAT'S HAPPENING WHEN?

FIND OUT ABOUT CRC ACTIVITIES BY EMAIL

THE CRC WILL NOTIFY YOU OF AN UPCOMING CRC ACTIVITY IN YOUR AREA OF INTEREST

You can register to receive this information on line at www.catchment.crc.org.au/subscribe

or you can contact Virginia Verrelli at the Centre Office on 03 9905 2704.

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

Print Post Approved
PP338685/00026

If undelivered return to:

Department of Civil Engineering
PO Box 60
Monash University
Vic 3800

SURFACE MAIL

POSTAGE PAID AUSTRALIA

CENTRE OFFICE:
CRC for Catchment Hydrology
Department of Civil Engineering
PO Box 60 Monash University,
Vic 3800
Telephone: +61 3 9905 2704
Facsimile: +61 3 9905 5033

crcch@eng.monash.edu.au

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 Sustainability and Environment, Vic
Department of Sustainable Natural Resources, NSW
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
Wimmera Mallee Water

Associates:
Water Corporation of Western Australia