NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 106 JUNE 2002

A NOTE FROM THE DIRECTOR

Professor Russell Mein

REFLECTIONS* FROM A RETIRING DIRECTOR

We invited ABC Science journalist Paul Willis to our Annual Workshop in Ballarat last month. He told us that the best talks, from the media perspective, feature both conflict and emotion. My comments tonight will perhaps have more of the latter; I'm not so good on conflict.

It started 12 years ago this month - the date that sticks in my mind is 20 May 1990. That is the day my life took a turn; the day that Emmett O'Loughlin and Graham Allison from CSIRO Division of Water Resources came to call. Graham had been talking with John Langford (then General Manager of Rural Water Corporation) about a Division presence in Victoria, and John had offered space at the Corporation.

Concurrently, the CRC Program to bring researchers and users of research together had been announced, with a call for 50 CRCs in the next three years. Was Monash interested? Was I interested? Who else should be contacted?

Well we never did get that group of CSIRO staff to move to Melbourne. I think we got something better - the CRC for Catchment Hydrology!

Timewise, I'm getting ahead of myself. I don't want to overlook the seemingly endless round of meetings to get organisations interested and involved, with the legwork delegated to Geoff Earl, chaired by John. Our bid was prepared for Year 1 of the Program, and was one of 120 submitted for the first fifteen slots. We were short-listed in the last 30. As a lead-up to the interview - then a full day of probing questions - we scheduled a practice. Dr John Zillman - head of the Bureau of Meteroology - was a 'pretend' interviewer (and was so impressed he said 'The Bureau should be in this!'). The interview seemed to go well, but when the results were announced the week before Christmas, we were not one of the successful fifteen.

It had been a struggle with a disappointing outcome, and some of us (including me) were prepared to cut our losses and drop out. Not John Langford - he argued that we were so close last time that next time would be a breeze. We had the Bureau on board this time, and that was perhaps the critical factor. At the all-day interview, we were limited in the numbers allowed on our side of the table, but had Rob Vertessy and Cathy Wilson outside and scheduled for 'lunchtime entertainment'. These couple of fresh-faced young scientists were fantastic, and gave us the clue for the next bid (ie. disregard the guidelines - always have extra troops waiting in the wings).

That bid was successful, and we thought we were away. Emmett organised a workshop of participants at Warburton in February 1992 to develop a set of possible projects, a very successful move to get people involved and thinking collaboratively. [We've used the same concept many times since, and with equal success].

A low point was coming. A CRC has to have quite detailed legal agreements, and John will remember chairing a meeting where every Party representative had their lawyer in tow. We went through the main agreement clause by clause, with discussion on nearly every one. It took a whole day, and I left thinking if that was what CRCs were all about, I could just as well opt out.

How wrong I was. When the Kennett Government took office soon after, it moved quickly to abolish the Rural Water Corporation. Other Government Departments changed too. Board members came and went after just one meeting or two. Without our legal agreements, the CRC would have been left in the cold. With them, the obligations were picked up by the successor organisations and/or people. It was a good lesson - written agreements (including Project Agreements) are essential for long-term understandings and security.

Year One (one-third funding) - John had us planning, planning, planning; not what academics were used to at all. We didn't like it, but it paid handsomely later on. We've continued the practice.

Year Three - Emmett announces he's going - after doing so many of the 'hard yards', and giving us such a great start. I decide to apply - not because I wanted the job - but more to ensure that the Selection Committee did not pick a turkey because I hadn't put my hand up! [Here I won't say 'gobble gobble'].

I went to that job interview with a document entitled 'Tasks for the next Director of the CRC', and was surprised to have it sent back to me with the position offer, saying this is what we want you to do.

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COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

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It was the start of what has been an amazingly challenging and rewarding seven years. Challenging in that the institutional makeup of our Parties was undergoing great change (this is still a lot of change about!); rewarding in what the CRC has achieved during that time. Lots of things stand out:

- *Catchword* and the wonderful communications vehicle it has been. (It also makes months seem very short as the deadlines come round again)
- The Technology Transfer Awards at the CRC Association conferences, with success twice in the first three years
- The CRC Young Water Scientist of the Year (three winners in five years), and indicative of the wonderful talent we have in our post-graduate program
- the work of the Flood Program which I led, and the extensive adoption of the outcomes in the revised Book 6 of Australian Rainfall and Runoff (the bible for this area of work)
- the forest hydrology projects and their influence on forest management practice
- the riparian zone work - I hadn't believed you could generalise what happens on streambanks. I was wrong
- the guidelines for evaporation basins to help manage salinity
- the powerful support for the new bid, both from the new Parties and the old
- the buzz at the Annual Workshops - I'm going to really miss that!
- the work on water sensitive urban design, the success of the Industry Seminars, the Stream Restoration Manual, SPROG, EMSS, MWATER, MUSIC,…

I could go on and on here, and hasten to acknowledge the partnerships which have been so productive and important.

We can all be proud as to what we have achieved. This Centre has been very successful, and you don't have to take my word for it - I *am* biased - but it's what our independent review panels have said, again and again. Last November, for instance, our Second Year Review Panel termed us a 'model CRC'. My favourite line, however, was in the Stage One report, where the two American reviewers stated that they had seen nothing comparable to the synergy between the research and application communities anywhere in the United States!

Responsible for these outcomes are the talented people who make up our CRC, and the outstanding people who make it happen. I am here really basking in their reflected glory.

This isn't the Academy Awards, and I won't name all the people I should - the list is a long one - but will mention four of the 'iron men' - people who have been there from the beginning in 1992. Without John Langford, we wouldn't have had a CRC when we did, or maybe at all. His continuing contribution at Board level has been enormous, and his personal counsel invaluable. John Molloy has 'made it happen' as a tireless and efficient Business manager; his attention to detail - including gourmet biscuits for Review Panels - is legendary. Tom McMahon and Rob Vertessy have been marvelous Deputy Directors for me throughout my term.

There have been many supporters, but none so important as my wife Wendy, here with me tonight. I could not have done this without her.

I'll finish with a rather personal 'highlight'. November 1997. During the crucial Fifth Year Review of the first CRC, my mother was in the last stages of a terminal illness; she died only two days later. It was a time of great pressure for me, and of wonderful support from so many in the CRC. I really appreciated that. When a Chair in my Department at Monash was advertised at that time, and colleagues urged me to apply, I didn't think twice. The CRC was where I wanted to be.

I thank you all for your attendance to honour me tonight.

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**[The CRC Board hosted a dinner in Canberra on 30 May 2002 to celebrate the achievements and contribution of Russell Mein, prior to his retirement. This is an edited version of his remarks on that occasion.]*

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

Report by Rob Vertessy

Catchment Modelling Toolkit

On the home stretch, but not done yet

Like the other programs in our CRC, Program 1 is now in the home stretch, as far as the first round of projects go. Right now, our focus is on refining our modelling frameworks (Tarsier, ICMS and TIME) and bringing some of our prototype models and modelling support tools into a form such that they can be integrated into the Catchment Modelling Toolkit. In this way they will become accessible to others in the land and water industry. However, before that can happen, we have a few important issues to resolve. Addressing them now will enable us to get off to a flying start with the second round of three-year projects starting in January next year.

Software licensing arrangements

The first issue to resolve is software licensing arrangements. Over the last couple of months the Centre Executive and Board have been thrashing out the details about how we approach Toolkit software licensing. Issues to consider including costing, liability, support and intellectual property rights. As some of our work is collaborative with non-CRC agencies we also have to consider how to share IP that is co-developed, and how our own IP might be affected when others add value to it down the track. We want to make the arrangements as simple and attractive to the industry as possible as our prime objective is to get the industry working with our products, and those developed jointly with other groups. It is likely that we will develop a small number of generic licenses so that we can bring individual Centre software products to the market with minimal fuss.

The Toolkit web portal

The second issue requiring attention is the Toolkit web portal at www.catchment.crc.org.au/toolkit. Our web guru Dan Figucio has put a handy site together that currently serves as an information resource on the Toolkit initiative. Over the coming months, that site will evolve into the Centre's portal for accessing all of our software and information related to it. We envisage different access arrangements for different software products. Users will be able to download some software directly over the internet. In other cases they will simply apply for access to software that will be distributed on CD. We are also exploring the virtues (and pitfalls) of providing web-server-based models that users can run remotely. From our perspective, two vital parts of the Toolkit portal will be the registration system that tells us who is licensed to use what software, and a 'user forum' that facilitates information flow between users of particular software products. Because our capacity to support users is limited, we are eager to erect a system whereby users can help one another.

During the next round of projects (starting January 2003) we expect the Toolkit software library to grow rapidly, but we certainly intend to start populating it over the next six months so that we can iron out various problems associated with delivering software to the big wide world. So, please keep tuned to the Toolkit web site and give us your feedback as the site evolves. To those developing and/or using models, I urge you to establish contact with the Toolkit team and share your ideas. We want you to come on board!

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NEW 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

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.

NEW TECHNICAL REPORT

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

by
Francis Chiew
Philip Scanlon

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.

Copies are available through the Centre Office for $27.50

For further information contact the Centre Office on 03 9905 2704

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by David Rassam and Heather Hunter

Flow regimes in riparian buffer zones

In Project 2.5 we are investigating the role of riparian zones in reducing nitrogen delivery to streams. In the August 2001 issue of *Catchword* we gave an overview of the project and highlighted nitrogen management in riparian zones as an important issue for protecting downstream water quality. We are particularly interested in identifying conditions that favour the process of denitrification (microbial conversion of nitrate to nitrogen gas) since this provides a means of removing nitrogen from the riparian zone to the atmosphere. Hydrology is a key factor affecting denitrification rates in the riparian zone.

In the December 2001 *Catchword* we discussed our initial insights into the hydrology of the experimental site, which is situated near Coochin Creek in the Glasshouse mountains area of south-east Queensland. In this issue we report on recent investigations that have increased our understanding of the site hydrology.

Overview of site hydrology

The study site is located in the riparian zone of a small tributary of Coochin Creek. The ephemeral stream that flows after rainfall feeds the groundwater system. We have identified two distinct water tables; a permanent water table that is connected to the regional groundwater system, and a local perched water table that is restricted to the flood plain. The latter occurs as a result of lateral flow from the stream. It remains as long as the stream is flowing and drains away after streamflow ceases. This subsurface flow occurs within the root-zone of riparian vegetation, where organic carbon levels are relatively high and conditions are favourable for denitrification processes to remove nitrogen from the water.

Flow rates in the perched water table

Knowledge of water flow rates is required to calculate residence times within the riparian zone and thus define the time available for denitrification to occur. We estimated the flow rate in the shallow perched watertable by conducting a natural-gradient, field tracer experiment in the floodplain. Two modelling approaches were then used to evaluate our results; an approximate analytical approach, and an inverse numerical approach that explicitly models convective-dispersive flow.

The experiment was carried out following rainfall in February 2002, which triggered stream flow. The water level in the designated shallow injection well was measured prior to commencing the experiment. Concentrated sodium chloride solution was added to increase the electrical conductivity (EC) to approximately 1600 μS/cm, against a background EC of about 200 μS/cm. The EC of the water in the injection well was monitored for two days. Results are shown in Figure 2.1.

The flow rate was first estimated from the rate of dilution of the tracer in the injection well, following the method of Drost *et al.* (1968). This assumes steady groundwater flow, homogeneous release of the tracer, no vertical movement within the well, and no density gradients induced by the tracer addition. Best fit to the experimental data (shown in Figure 2.1) was obtained from an actual flow rate of 6.6 cm/day.

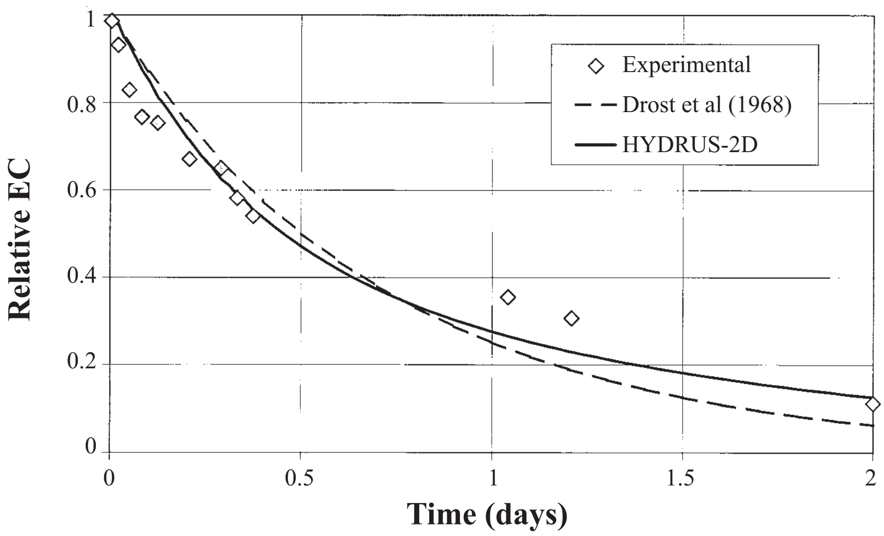

Figure 2.1: Observed and modelled concentrations in the injection well, field tracer experiment.

The model HYDRUS-2D (Simunek *et al.* 1999) was also used to simulate the tracer experiment. It is a finite element program that simulates coupled two-dimensional water movement in variably saturated media and convective-dispersive solute transport. The imposed hydraulic boundary conditions were identical to those prevailing in the field; that is, a constant head boundary condition at both sides of the domain with a gradient of 1% and a no-flow boundary condition at the base (since the conductivity of the silty clay layer is negligible). Initial EC values in the injection well and the neighbouring soil were set to 1600 and 200 (S/cm, respectively. The model was run in inverse mode to optimise for the hydraulic conductivity; that is, the hydraulic conductivity was varied until the best fit to the experimental data was obtained. The best fit (Figure 2.1) was obtained with a hydraulic conductivity of 475 cm/day, an estimate close to the average value obtained previously from laboratory measurements. The flow rate under these conditions was about 7 cm/day, which is comparable to that obtained using the Drost et al. (1968) method.

Overall comments

The observed low flow rates in the perched water table translate to residence times within the riparian zone of sufficient length for effective removal of nitrate through denitrification. These residence times, coupled with the high organic carbon content of shallow riparian zone soils, indicate a high potential for denitrification to occur in the perched water table system.

References

Drost, W., Klotz, D., Koch, A., Moser, H., Neumaier, F., and Rauert, W. (1968). Point dilution methods of investigating ground water flow by means of radioisotopes. Water Resources Research, 4:125-146.

Simunek, J., Senja, M, and van Genuchten, M. Th. (1999). HYDRUS-2D, V2 software package for simulating water flow and solute transport in two-dimensional variably saturated media. U.S. Salinity Laboratory, Agricultural Research Service, U.S. Dept. Agriculture, Riverside, California.

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PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by John Tisdall

Behaviour in water markets

The current economic research in Project 3.2 is using laboratory experiments to observe human behaviour in water markets. The advantages of using economic experiments, as with any other form of experimentation, are that extraneous factors can be controlled and the results can be replicated. The idea is to capture the essence of water users' behaviour.

Typical questions which may be answered in such experiments include:

- "Do water users change their water use behaviour if they are aware of -
  - possible environmental damage
  - increases in water tariffs, or
  - changes to trading rules or entitlements?"

Water-trading methodology

The methodology for the project, coined MWater, involves giving participants a model farm where rainfall - surprisingly enough - is unknown, and decisions on cropping, water use and trade have to be made. Experiments have been used in the focus catchment to test-bed the methodology and as an educational tool. One of the main barriers to water trading is hesitation and knowledge of what the market offers, how prices are determined, and what strategies work and don't work.

Feedback from participating farmers has been extremely positive, even from those who got upset because their crops failed due to a lack of rain. Many said that they came knowing nothing and with many preconceived ideas of what to expect. They left with the feeling that they now know how to work in a water market environment.

Project benefits

The success of the project is three-fold. The researchers are exposed to new and interesting methodologies, the industry stakeholders have an opportunity to trial new policy options prior to their release, and the farming community has an opportunity to experience water trading without placing their farm assets on the table.

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

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.

Copies are available through the Centre Office for $27.50

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

NEW TECHNICAL REPORT

THE STATUS OF CATCHMENT MODELLING IN AUSTRALIA

by

Frances Marston
Robert Argent
Rob Vertessy
Susan Cuddy
Joel Rahman

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

The real test of the methodology came at the project review meeting where the panel, including Russell Mein, sat down without notice and traded with Griffith University students. While no quarter was given, everyone enjoyed it and appreciated the realism of the experiment.

Indications from current work

Currently we are experimenting with temporary water markets where farmers trade water with each other on a monthly basis throughout a water year. In similar fashion to real markets, traders in the laboratory markets, being relatively risk adverse, enter the market early to secure water and as the price rises they offer surplus water for sale. As the market progresses the number of buyers diminishes as summer crop demand falls away. Once the summer growing season finishes demand decreases, supply increases and the equilibrium price falls.

Figure 3.1 shows monthly equilibrium prices through the three years of the experimentation. It was expected that the market would show a cyclical pattern through each year reflecting the crop requirements and seasonal conditions. In year 1 experiments equilibrium prices remained stable with two four-month price steps. In years 2 and 3 a more cyclical pattern began to form with prices increasing during the summer months and then decreasing as the season closes.

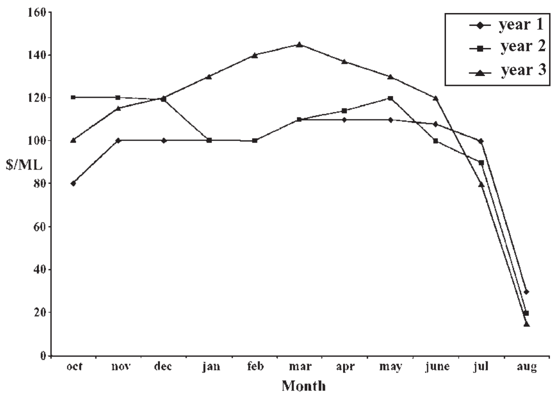

Fig. 3.1 Ways to transfer water entitlements

Overall comments

Modelling this market behaviour from field and laboratory experiments can be used to explore more fully than ever before the hydrological, economic, social and environmental consequences of water use in a market environment.

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PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Tim Fletcher*

(*with contributions from Tony Weber, Margaret Greenway, Lucy Peljo, Geoff Taylor & Hugh Duncan)

Research on wetlands: improving the prediction of stormwater quality processes

The Urban Stormwater Quality Program of the CRC has undertaken extensive research into the role of constructed wetlands in improving the quality of urban stormwater. In 1998, as a result of this research, the CRC released an Industry Report entitled "Managing Urban Stormwater Using Constructed Wetlands" (Wong et al., 1998). This report outlines the wetland design considerations that are necessary to achieve effective removal of urban stormwater pollutants.

Research into constructed wetland performance has also been used in the development of the CRC's MUSIC (Model for Urban Stormwater Improvement Conceptualisation) software. The algorithms in MUSIC that describe the water quality improvement in a range of stormwater treatment measures (including wetlands) are referred to as the Universal Stormwater Treatment Model (USTM). The USTM describes the physical processes (filtration and sedimentation) that occur when pollutants are first intercepted during a storm event (Wong et al., *in press*).

Current and future CRC research is therefore aiming to further improve the calibration and prediction of the parameters for the USTM, to better understand the impact of local conditions, and the role of inter-event processes, on the overall behaviour of pollutants in constructed wetlands. Three examples of this research are presented below.

Types of Nitrogen and wetland processes between storms: Ruffeys Wetland (Melbourne) – Background

Treatment processes in constructed stormwater wetlands include physical, biological and chemical functions operating under dynamic hydrologic and hydraulic conditions. Depending on the proportion and types (or speciation) of nitrogen entering stormwater wetlands from urban catchments, various treatment processes will occur during or between storm events. The composition of nitrogen in urban stormwater includes both organic (present as plant debris or in particulate form) and inorganic (e.g. ammonium, NO_x, N_2). To achieve the desired transformation and removal of nitrogen from stormwater treatment wetland processes, it is important to be able to identify the fraction of organic and inorganic nitrogen in urban runoff. Identifying the nitrogen helps to ensure that the wetland design incorporates the appropriate treatment processes responsible for nitrogen removal for event and inter-event storm periods.

Analysis of nitrogen composition from a range of monitoring stations within urban catchments in Australia and the U.S.A has illustrated the diverse proportions and range of nitrogen species entering stormwater treatment facilities from urban runoff. Being able to predict these proportions will allow wetland design to be better targeted for nitrogen removal.

Due to the sporadic nature and dynamic hydraulic properties of storm events, the processes most likely to treat nitrogen during storms are physical (Table 4.1). Nitrogen species most likely treated by physical processes include leaf debris and particulate nitrogen, which settle out in the inlet zone and ephemeral zone of stormwater treatment wetlands.

Transformation processes occurring in wetlands include chemical and biological processes. These processes alter the molecular properties of nitrogen and include the transformation and removal mechanisms (chemical and biological) outlined in Table 4.1. Transformation processes are energy-consuming processes and thus require an energy source, which is typically derived from carbon.

The environmental factors that regulate these transformation processes need to be incorporated into the design of constructed wetlands to maximise their treatment efficiency.

Physical Removal Processes	Transformation Processes (Chemical and Biological)
Particulate settling and re-suspension	Ammonification (mineralisation)
Diffusion of dissolved forms	Nitrification
Plant uptake and translocation	Denitrification
Litter fall	Nitrogen fixation
Ammonia volatilisation	Nitrogen assimilation
Sorption of soluble nitrogen on substrates	Biofilm uptake
Seed release	
Organism migration	

Table 4.1. Physical removal and transformation processes in stormwater wetlands

– Field experimentation

Ruffeys Wetland, located in Doncaster Victoria, is a relatively small wetland, incorporating an open water inlet zone, and densely vegetated macrophyte cells (Figure 4.1). The design and scale of this wetland make it suitable for detailed investigation of treatment processes. The work being undertaken here (by Monash University PhD student, Geoff Taylor), aims to:

- Determine the types of nitrogen present in urban stormwater runoff entering the wetland,
- Identify and quantify nitrogen transformation and removal processes in constructed stormwater treatment wetlands occurring during and between storm events, and
- Enhance existing wetland design guidelines to maximise nitrogen removal during and between storm events,

Figure 4.1. Ruffeys Wetland

The first stage of this project involves the collection of data on types or species of nitrogen, both during and between storm events. This will be undertaken across a number of urban catchments, in both Melbourne and Brisbane. The project's second stage will monitor the chemical, biological and physical processes occurring in Ruffeys Wetland, between storm events, focussing on those processes impacting on the fate of nitrogen.

– Integrated wetland monitoring: Bridgewater Creek wetland (Brisbane)

Brisbane City Council has recently retrofitted a constructed wetland into an urban parkland on Bridgewater Creek, Coorparoo. Incorporating design elements based on recent CRC research, this wetland demonstrates the on-ground application of research into a functioning water quality improvement facility using best management practice.

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)
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NEW TECHNICAL REPORT

THE DEVELOPMENT OF WATER REFORM IN AUSTRALIA

by
John Tisdell
John Ward
Tony Grudzinski

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.

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

The design of the wetland area (2 ha) consists of four integrated hydraulic elements which combine to satisfy the operational requirements of the wetland for both water quality and water quantity. The four elements are:

- Inlet Zone
  The inlet zone includes two Gross Polluted Traps (GPTs) located on each of the inflowing tributaries (total catchment area of 140 ha), and a sediment basin.
- Macrophyte Zone
  The macrophyte zone includes open water, deep marsh, shallow marsh and ephemeral zones.
- Outlet Zone
  The outlet zone consists of water level control structure, spillways, weirs and a culvert.
- High Flow By-Pass
  The bypass channel conveys storm flows around the macrophyte zone to protect the macrophytes from high flow disturbances.

Figure 4.2 shows the area prior to wetland construction and Figure 4.3 shows the wetland post-construction. Note that the macrophytes are yet to fully establish.

Bridgewater Creek Wetland (May 2002)

This wetland applies most elements of good wetland design, and the performance will be evaluated in detail by Brisbane City Council and the CRC.

– Water quality monitoring

Water quality monitoring commenced prior to the construction of the wetland. Initially, grab samples were collected from the concrete-lined channel. One automatic sampler was then installed downstream of the wetland to monitor during storm events. Since the completion of the wetland an additional two automatic samplers have been installed at each of the two inlets.

In addition to the automatic samplers that collect during storm events, baseflow monitoring is undertaken on a monthly basis. Additional automatic samplers are scheduled to be installed in the first two macrophyte ponds to evaluate pollutant decay. This will also enable model parameters to be calibrated, for local application of the CRC's MUSIC software by Brisbane City Council, other agencies and consultants.

Figure 4.2 Bridgewater Creek - prior to the construction of the wetland

Figure 4.3 Bridgewater Creek - post-construction

– Vegetation Assessment

Researchers from Griffith University (led by Assoc. Prof. Margaret Greenway) will evaluate the establishment of the aquatic floral communities (macrophytes) in the wetland. The aquatic floral communities will be assessed using twenty cross-sectional transects placed at various locations along the wetland system. Vegetation along these transects will be assessed in terms of survival rates, colonisation of planted and new species, and relative density for each vegetation layer (submerged, floating and emergent) (Figure 4.4). This will allow the construction of cross-sectional profiles of the wetland showing the vegetation zonation and changes in density with depth and position in the system. Low-level aerial photography will also be used to assist the assessment of the extent and density of aquatic vegetation throughout the system.

Figure 4.4 Vegetation transect in Bridgewater Creek wetland.

– Mosquito Monitoring

As part of the Monitoring Program, mosquito monitoring is being used to ascertain whether the wetland provides a habitat for mosquitoes to breed. Sampling is undertaken fortnightly at five locations around the margins of the Bridgewater Creek wetland. A dipper with a capacity of approximately 200 ml is used to search for mosquito larvae at the margins of the water body, with 10 dips taken at each point.

– Faunal Biodiversity

The presence or absence of aquatic fauna will provide an indication of both water quality and ecological health. The study will focus on several faunal groups, including:

- Macroinvertebrates - species composition and diversity
- Fish, amphibians, and turtles - native species richness, percentage exotic individuals and habitat preference; and
- Bird species - species diversity and abundance, and habitat preference.

All of these faunal communities will be assessed for colonisation rates and the composition of native versus exotic species.

– Community Ownership

A community survey (similar to that reported for Cressey St. Wetland in *Catchword* No. 84, June 2000) will be undertaken as part of the monitoring program to determine awareness of the wetland, including its function and community acceptance. The key objectives of the community consultation survey are to:

- Determine the residents' attitudes to the wetland;
- Gauge current awareness of the wetland and what role it plays in the local environment; and
- Determine recreational use by the residents.

Melbourne Water wetlands monitoring program: Hampton Park wetland (Melbourne)

Melbourne Water constructs a number of large stormwater treatment wetlands each year, and is working in partnership with the CRC to evaluate the effectiveness of these wetlands. There are three principal objectives of this monitoring program:

- To report the stormwater treatment performance of the wetlands, to satisfy audit and funding body requirements,
- To enhance the calibration of MUSIC for local conditions.
- To assist in the ongoing refinement of wetland design.

– Experimental Approach

The approach being taken to experimental design for this project aims to maximise the quality of monitoring data, to allow for reliable prediction of the performance of future wetlands constructed by Melbourne Water. In other words, rather than trying to monitor the performance of every constructed wetland, Melbourne Water is undertaking intensive monitoring of three wetlands over the next three years. The results obtained from this monitoring will allow MUSIC's parameters to be reliably calibrated for use in simulating the performance of Melbourne Water's other wetlands.

The first wetland to be monitored will be Hampton Park, in Melbourne's south-east (Figure 4.5). Flow meters and water quality autosamplers will be installed on each inlet, the outlet, as well as locations within the wetland.

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 will be available from the Centre Office in mid-June 2002 for $88.00

Individuals will need to sign a Licence Agreement (available from the Centre Office)

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.

URBAN STORMWATER TECHNICAL REPORT

WATER SENSITIVE URBAN DESIGN IN THE AUSTRALIAN CONTEXT - CONFERENCE SYNTHESIS

by
Sara Lloyd

Report 01/7

In August 2000 a conference was held in Melbourne to highlight and explore the opportunities and impediments to the adoption of Water Sensitive Urban Design (WSUD). WSUD is the term used to describe a new approach to urban planning and design that offers sustainable solutions for the integration of land development and the natural water cycle.

This report collates and summarises the key issues raised at the conference, focusing on the current barriers to the widespread adoption of WSUD principles and offers possible solutions to help overcome both short term and long term issues.

Copies available through the Centre Office for $27.50.

For further information contact the Centre Office on 03 9905 2704

Figure 4.5. Hampton Park Wetland.

Overall comments

The CRC has worked closely with its industry parties, Brisbane City Council and Melbourne Water, to help them predict the performance of a range of stormwater treatment facilities, including constructed wetlands. Delivery of MUSIC has been a significant output from this research. Ongoing fundamental research is required, however, to enhance the prediction of stormwater treatment performance in constructed wetlands. The well-proven collaborative approach will again be utilised to undertake this work. At the same time, the CRC is undertaking further research into a range of other stormwater treatment facilities, and these projects will be discussed in future editions of *Catchword*. Watch this space!

References

Wong, T. H. F., Breen, P. F., Somes, L. G., & Lloyd, S. D. (1998). *Managing Urban Stormwater using Constructed Wetlands* (Industry Report 98/7). Melbourne: Cooperative Research Centre for Catchment Hydrology.

Wong, T. H. F., Fletcher, T. D., Duncan, H. P., Coleman, J. R., & Jenkins, G. A. *(In press). A model for urban stormwater improvement conceptualisation.* Paper presented at the Biennial Meeting of the International Environmental Modelling and Software Society, Lugano, Switzerland

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PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Andrew Western

Murray-Darling Basin and Global Energy and Water Cycle Experiment (GEWEX)

Early this year the Murray-Darling Basin Water Balance Project (MDBWBP) was approved as a GEWEX Catchment Scale Experiment (CSE). In this article we provide some background on GEWEX and the MDBWBP, and outline the role being played by CRC Project 5.1: 'Modelling and forecasting hydroclimate variables in space and time'.

GEWEX, the Global Energy and Water Cycle Experiment, was initiated in 1988 by the World Climate Research Program. GEWEX aims to "observe, understand and model the hydrological cycle and energy fluxes in the atmosphere, at land surface and in the upper oceans" (http://www.gewex.org/). It is motivated by a desire to improve predictions of regional and global climate change.

The GEWEX www page states that the objectives of the program are to:

- Determine the hydrological cycle and energy fluxes by means of global measurements of atmospheric and surface properties.
- Model the global hydrological cycle and its impact on the atmosphere, oceans and land surfaces.
- Develop the ability to predict the variations of global and regional hydrological processes and water resources, and their response to environmental change.
- Advance the development of observing techniques, data management, and assimiliation systems for operational application to long-range weather forecasts, hydrology, and climate predictions.

GEWEX has three research foci concentrating on Radiation, Hydrometeorology, and Modelling and Prediction. GEWEX catchment scale experiments are run within the hydrometeorology focus and they include GAPP, BALTEX, GAME, LBA, MAGS and now MDBWBP (they provide lots of material for acronym aficionados).

Murray-Darling catchment scale experiment

The Murray-Darling Basin Water Balance Project (MDBWBP CSE) (http://www.gewex.org/mdb.html) includes contributions from a number of research organisations within Australia including the CRC for Catchment Hydrology, the Bureau of Meteorology Research Centre (BMRC), The University of Melbourne, CSIRO Land and Water, Macquarie University, and the Australian Nuclear Science and Technology Organisation (ANSTO). Objectives of MDBWBP are to:

- Monitor and predict key components of the daily water budget across the Basin;
- Develop real-time products on key components of the water budget for use by water agencies;
- Observe, understand and model the processes controlling soil moisture in the Basin; and
- Improve the representation of land surface processes in weather and climate models

It is being managed by Dr Michael Manton from the BMRC.

Key site feature

A key physiographic feature of the Murray-Darling Basin that led to its selection as a catchment scale experiment site is that it largely represents a semi-arid zone. Its ratio of discharge to precipitation is extremely low (less than 0.05) due to the potential evaporation rate being more than twice the precipitation rate. Other CSE sites are more humid.

Soil moisture monitoring

The CRC for Catchment Hydrology has recently established a soil moisture monitoring network across the Murrumbidgee catchment (see July 2001 *Catchword*), which represents about 10% of the area of the MDB and almost the full range of climate within the MDB. The network consists of eighteen stations, eight of which are installed in close proximity to Bureau of Meteorology recording stations (mainly automatic weather stations), often at airfields. The other ten stations are installed in two groups of five distributed across Kyeamba (near Wagga Wagga) and Adelong (near Tumut) Creeks (Figure 5.1).

The soil moisture stations have sensors that measure soil moisture in the 0-7cm, 0-30cm, 30-60cm and 60-90cm layers. These approximately correspond to the top three layers (0-7cm, 7-28cm, 28-100cm) in the landsurface model (VB95) utilised in the Bureau's numerical weather prediction models. In addition to soil moisture, soil temperature and soilwater suction (60-600kPa) are measured at the midpoint of each moisture sensor and rainfall is measured using a tipping bucket pluviometer. Data are recorded at intervals of 6 minute [rain, temperature] and 30 minute [moisture and suction] and are telemetered back to the University of Melbourne weekly via mobile phone links for checking and archiving. The data will be made available progressively via the www.

Soil moisture data

Figures 5.2 to 5.4 show data from the Canberra soil moisture station collected between September 2001 and March 2002. Responses of soil moisture and soil suction to wetting and drying events are clearly evident in the data. The general behaviour is as would be expected with the surface layers being most responsive and the deeper layers responding only to large rainfall events and seasonal evaporative demands. Figure 5.4 shows the temperature data. The data have been offset by multiples of ten degrees for clarity and the traces appear in depth order down the graph. Daily average temperatures at each depth change from about ten to twenty degrees from spring to summer. Again the surface is most responsive with a strong diurnal signal, and temperature below 50cm responds only at synoptic and seasonal timescales.

Comparisons of sites

Differences between sites will be important when we are testing the land surface model because they will provide a wider range of test conditions. Figure 5.5 shows soil moisture at the Hay field-site. Comparing Hay and

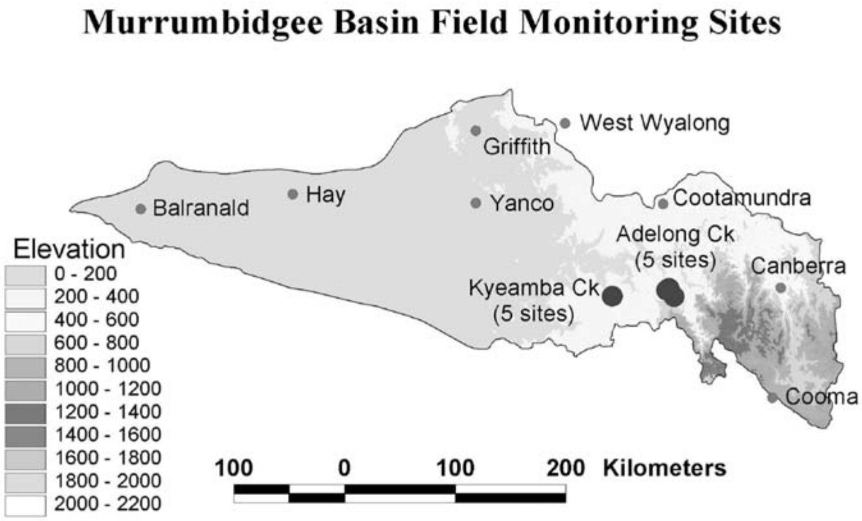

Figure 5.1. The Murrumbidgee soil moisture monitoring network.

NEW WORKING DOCUMENT

GENERATION OF SPATIALLY AVERAGED DAILY RAINFALLS FOR THE YARRA REGION

by

Lionel Siriwardena
Ratnasingham Srikanthan

Working Document 02/1

This document describes the data preparation and the generation of areal average rainfall for the Yarra catchment.

Two daily rainfall generation models, the Transition Probability Matrix (TPM) model and a modified Wang-Nathan Model (WNM), were used to derive spatially averaged daily rainfall sequences for a region encompassing the Yarra catchment in Victoria, one of the focus catchments in the CRC for Catchment Hydrology. The performance of the two data generation models was evaluated with respect to their ability to preserve various important rainfall characteristics at daily, monthly and annual time scales.

Copies are available through the Centre Office for $22.00.

PREFER YOUR *CATCHWORD* BY EMAIL?

Almost one third of *Catchword* readers receive their copy by email. Each month the Centre sends out a pdf copy of *Catchword* to email subscribers as well as a link to the CRC website from which *Catchword* can be downloaded.

If you would like to reduce the paper on your desk please contact the Centre Office on 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au

Over 1200 people receive *Catchword* each month.

Canberra (Fig. 5.2) shows clear differences in moisture dynamics, particularly in the 0-30cm layer and the deeper layers. These are mainly related to differences in event rainfall depths, which lead to deeper wetting at Canberra as a consequence of that site receiving about three times as much rain over the period of data. Note that these soil moisture data are uncalibrated and the differences between absolute moisture contents of layers may not be realistic.

Further sampling

Further experimental work on soil moisture in the Murrumbidgee will involve sampling along ten km transects using the University of Melbourne's Green Machine. With the data collected we aim to assess the representativeness of the point locations being monitored, for areas similar to the Bureau's weather model grid scale. This transect sampling will be supplemented by analysis of remote sensing images of surface temperature, which can be related to moisture availability for evapotranspiration.

Model testing

We have now collected sufficient data to be able to begin the process of model testing. There will be several facets to this work. These will revolve around both "offline" simulations of soil moisture and temperature by the Bureau's land surface model VB95 against measurements over longer periods, as well as comparing the soil moisture predictions of the coupled weather prediction model. The offline simulations test the ability of VB95 to simulate the processes affecting soil moisture in the absence of forcing errors (except of course observational errors). The coupled simulations will focus on both how well the initial soil moisture is set during forecasts and the ability to forecast a short time ahead. This will include an analysis of the importance of different sources of model errors (eg. simulated forcing such as rainfall, the data assimilation scheme setting initial soil moisture and VB95 model errors).

Further information

Further information on the Murray-Darling Basin Water Balance Project (MDBWBP) catchment scale experiment (CSE) can be obtained from Dr Michael Manton [Tel: (03) 9669 4444, Email: m.manton@bom.gov.au]. Further information on soil moisture monitoring in the Murrumbidgee catchment can be obtained from Dr Andrew Western.

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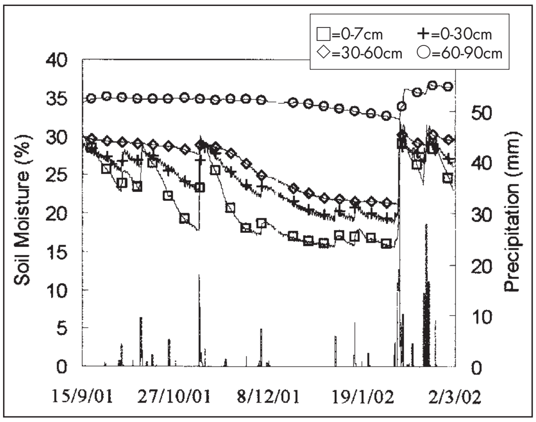

Figure 5.2. Soil moisture at Canberra.

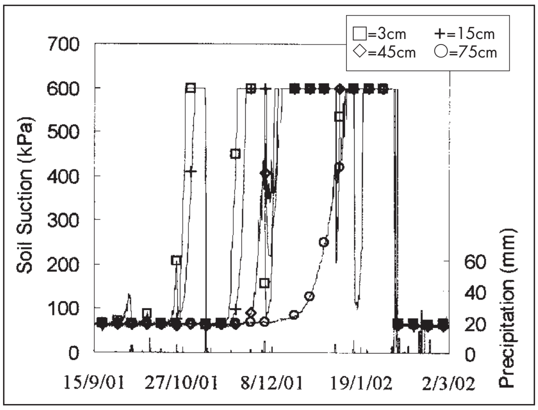

Figure 5.3. Soil suction at Canberra.

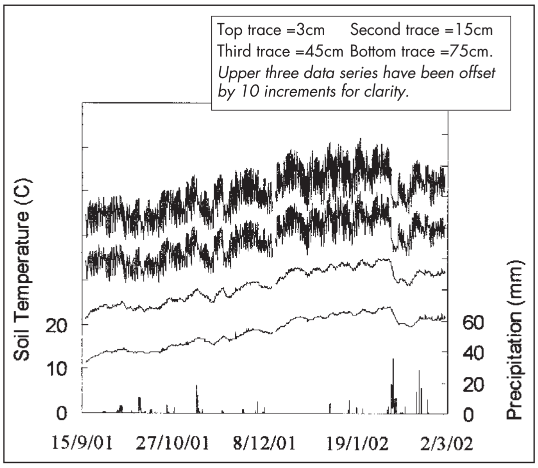

Figure 5.4. Soil temperature at Canberra.

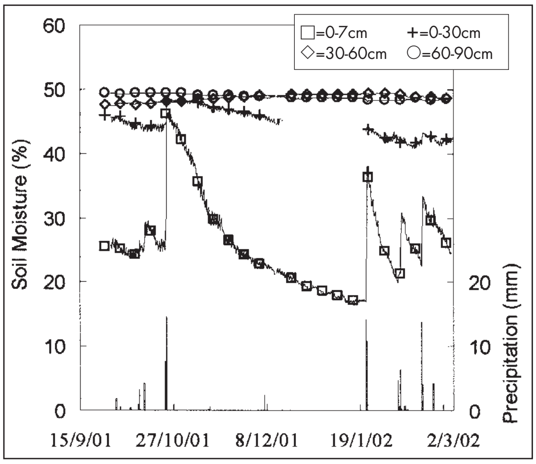

Figure 5.5. Soil moisture at Hay.

PROGRAM 6

RIVER RESTORATION

Program Leader
IAN RUTHERFURD

Report by Lindsay White

Native fish rise again: towards more effective fishways

As part of CRC Project 6.8: "Research to improve the effectiveness of Australian fishway design", I have nearly completed my PhD research on two fishway types that have been used in the Murray-Darling Basin, and in Australia generally. These types are the vertical slot fishway and the fishlock.

A major contemporary survey of the opinion of 'fishways professionals' in Australia suggested that these types of fishways are generally preferred for average water level differences across instream barriers of 4 metres and 7 metres respectively. Given these preferences, it is not suprising that most of the fishways to be constructed in a program of over $10 million to provide upstream fish passage along the Murray from the mouth to Hume Dam will be of the vertical slot type. A fishlock is currently being designed for Balranald Weir on the lower Murrumbidgee River.

Research on fishways

My research has been on the hydraulic conditions and fish behaviour within these two fishway types, and the peak sustained swimming ability of fish. An example of results from the fishlock at Yarrawonga Weir (Figure 6.1) is given below.

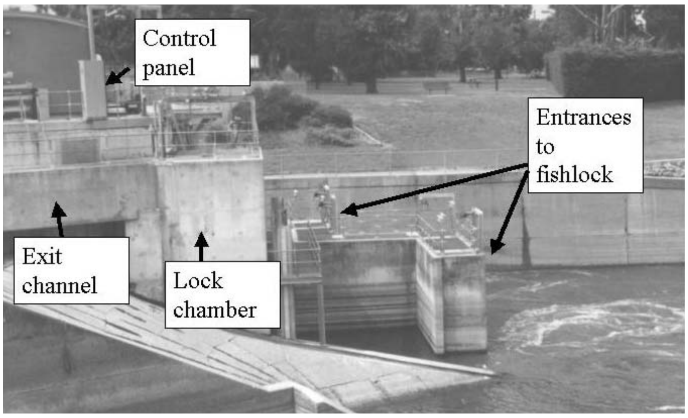

Figure 6.1 - Yarrawonga fishlock

A previous assessment of this fishlock indicated that research was required to determine the optimal exit duration of the exit stage to allow fish to move from the lock chamber into the exit channel upstream. Further, based on anecdotal advice from the weirkeepers and the literature, it also seemed reasonable that the water velocity in the exit channel would also affect whether fish choose to move into the exit channel.

Success of fish in leaving fish channels

The relationship between a measure of success (the *net exit percentage*, defined as the percentage of fish trapped in the exit channel to those in the experiment) and each of the exit duration, and the water velocity in the exit channel, are shown on Figures 6.2 and 6.3 respectively. The results suggest that a water velocity of 0.4 - 0.6 m/s and an exit duration of about 10 minutes (considerably less than the previous standard operating practice of one hour) increased the net exit percentage and hence the effectiveness of the fishway.

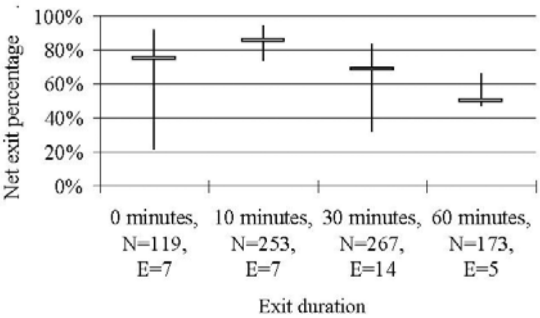

Figure 6.2 - Relationship between exit period and net exit percentage. The horizontal bars represent the median, and the vertical bars represent the inter-decile range. The exit period of zero minutes corresponds to when a gate at the downstream end of the exit channel was just raised above the water surface. Any fish that exited must have swum underneath the rising gate. E is the number of experiments (there was a minimum sample size of five for inclusion) and N corresponds to the number of fish.

SPECIAL JOURNAL ISSUE ON ENVIRONMENTAL FLOWS

Australian Journal of Water Resources Environmental Flows - theory, practice and management published by the The Institution of Engineers, Australia.

Guest Editors

Mike Stewardson
Lance Lloyd
Andrew McCowan

This special issue provides eight papers and two technical notes on the subject of environmental flows. Some papers document a selection of presentations at a one-day seminar on environmental flows hosted by IEAust, the River Basin Management Society and the CRC for Catchment Hydrology held in Melbourne last November. Other papers on relevant environmental flow issues are also included.

There is limited availability of this issue. Copies can be purchased through the Centre Office for $27.50 including GST and postage and handling. Contact Virginia Verrelli on 03 9905 2704.

CONFERENCE PROCEEDINGS

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

27-29 August 2001

Brisbane, Queensland

Copies of the recent 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.

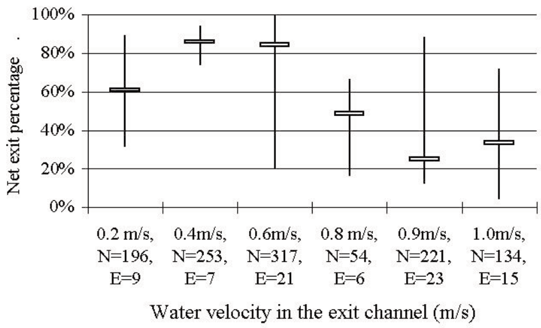

Figure 6.3 - Relationship between water velocity and exit channel and net exit percentage. The horizontal bars represent the median, and the vertical bars represent the inter-decile range. E is the number of experiments (there was a minimum sample size of five for inclusion) and N corresponds to the number of fish.

Video cameras

During the fieldwork, underwater video cameras were also used to observe fish behaviour in the exit channel. An example of a photo of a Murray cod that was approximately 85 cm in length is given in Figure 6.4. The cod seemed to be checking if the camera was edible!

Research outcomes

My research will expand the knowledge base underpinning the design of future fishways in the Murray-Darling Basin, and in Australia more generally. My recommendations for future research will include expanding the range of proven fishway types in Australia, and facilitating downstream passage by the adaptation of bypass systems used overseas.

Thanks and acknowledgements

Given I am in the home straight (or the 'exit channel'!) of my PhD, I will take this opportunity to express gratitude to some people. I thank my supervisors (Bob Keller, John Harris [CRC for Freshwater Ecology] and Ian Rutherfurd), and colleagues Tony Ladson, Frank Winston, Andrew Barton and Peter Kolotelo, for their insight, support and enthusiasm. I acknowledge the contributions to Goulburn-Murray Water and the Murray-Darling Basin Commission, both CRC for Catchment Hydrology industry partners, for their valuable assistance with fieldwork. I also acknowledge the support of the CRC for Catchment Hydrology more generally.

The future

It is my hope that this research, and other research on stream restoration in CRC for Catchment Hydrology and CRC for Freshwater Ecology, will assist native fish species to 'rise again' in the context of other legitimate demands on our scarce water resources.

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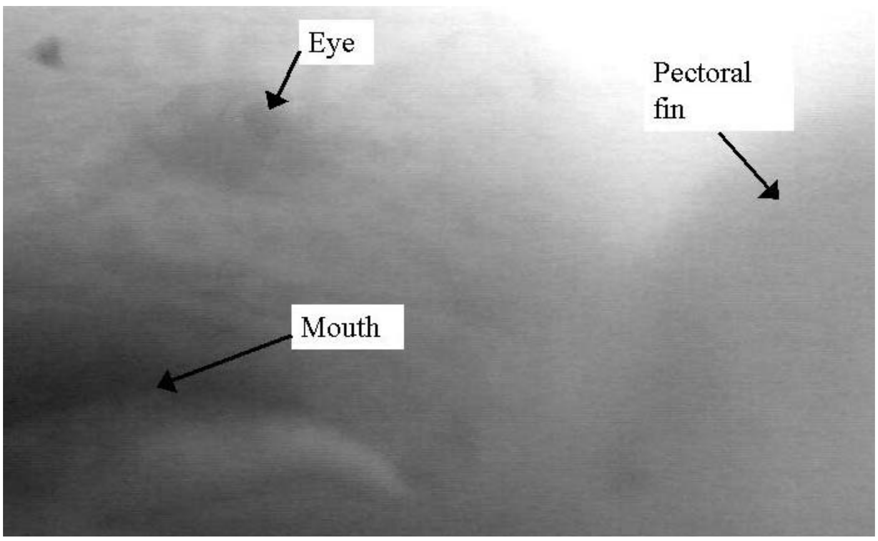

Figure 6.4 - Photograph of Murray cod ('grabbed' from video footage using an underwater camera)

PROGRAM 7

COMMUNICATION AND ADOPTION

Program Leader
DAVID PERRY

The Flow on Effect - June 2002

At a glance – a summary of this article

The term 'adoption gap' describes a missing component of a communication and adoption process critical to ensuring the delivery of useful products to industry. The CRC is well placed to bridge adoption gaps through collaboration between research and industry groups.

Adoption Gaps - the Transition of Research Outputs to Operational Products

Recently I attended a presentation by Carolyn Young, our Murrumbidgee Focus Catchment Coordinator, on the progress of the CRC's Communication and Adoption Program in the Murrumbidgee focus catchment. In her presentation, Carolyn described activities in the catchment and noted that a lot had been achieved in terms of facilitating awareness and understanding. Carolyn also described the existence of an 'adoption gap' and on reflection, I am finding the term quite useful (thank you Carolyn).

An adoption gap?

I am familiar with the term 'research gap' to describe a situation or process for which researchers do not have a complete, or more often 'a workable' level of knowledge. A research gap suggests a particular 'parcel of knowledge' and its relationship to the bigger picture is uncertain or in many cases, unknown. The CRC's research program is addressing many research gaps ultimately to improve the land and water management industry's capability to predict catchment behaviour.

Carolyn referred to something altogether different - a missing part of the communication and adoption process by which research products become operational products. Her comments started me thinking about how the CRC manages the development of research products and bridges these potential 'adoption gaps'.

Delivering research products - a complex business

The delivery of research products to end-users is a complex business. Research products or outputs are often raw, relatively unrefined advances in capability or knowledge. They are created in a research environment that is often very different to the environment where industry will apply them. Consequently most of the time CRC research teams are unable to simply 'hand over' a research product to industry for application.

Recognising this issue, the CRC uses a research project planning framework that includes:

- Forward looking strategic workshops involving senior managers from land and water management across Australia
- CRC Board participation in defining strategic issues and directions
- Technical advisory groups (TAGs) that include representatives from the research and industry Parties and end-user groups
- Planning and implementing a communication and adoption strategy

All of these activities facilitate a dialogue between CRC Parties to ensure that research projects, and in particular research outputs, evolve as much as possible in a context of industry application. While this dialogue is effective during the planning and implementation of research projects, it doesn't guarantee that the product is 'fully developed' and ready for industry at the end of the research project's duration. In these cases it may be that the 'research gap' requires further research to be addressed, or there may be an 'adoption gap' where a research product requires further development before it can be applied in industry. In the latter case CRCs are often at an advantage over other research Centres.

Ensuring research products are applied

Where research products do not yet meet the needs of the industry users, further development requirements can be extensive and beyond a research team's capability. In these cases, a collaborative approach between research and industry Parties is essential. By working together the research and industry teams are able to jointly develop a product to meet the 'operational environment' and ends-user needs

MUSIC - investing to bridge an adoption gap

The development of decision support system (DSS) software in Program 4 is an excellent example of the CRC's capacity to recognise and bridge adoption gaps. The software, better known as MUSIC (Model for Urban Stormwater Improvement Conceptualisation) featured in this Program's article last month (*Catchword*, May 2002).

Through an extensive consultation process early on in the project, the Urban Stormwater Quality research team constructed a clear picture of what industry users required from an urban stormwater DSS. A prototype (or beta version) was developed which required testing

UPDATED EVAPOTRANSPIRATION AND RAINFALL MAPS FOR AUSTRALIA

Where to get them!

The CRC for Catchment Hydrology and the Bureau of Meteorology have recently completed a project to produce national maps of evapotranspiration for Australia.

The map set is now available for $33 plus postage and packaging.

They can be purchased from:

1. **Publications Section, 9th floor, 150 Lonsdale St Melbourne. tel: 03 9669 4000 (main switch) and ask for Publications**

OR

2. **Bureau Regional Offices (all capital cities) Contact details for each Regional Office are available at http://www.bom.gov.au/inside/contacts.shtml**

Information about the climate atlas map sets and the digital map data sets can also be obtained from: National Climate Centre Ph: 03 9669 4072 Email: webclim@bom.gov.au

Technical queries about the evapotranspiration modelling can be referred to Dr Francis Chiew at The University of Melbourne email f.chiew@civag.unimelb.edu.au

Any technical queries about the mapping should be referred to Graham de Hoedt tel 03 9669 4714 email: g.dehoedt@bom.gov.au

NEW WORKING DOCUMENT

GENERATION OF ANNUAL RAINFALL DATA FOR AUSTRALIAN STATIONS

by

Ratnasingham Srikanthan
Tom McMahon
Geoff Pegram
George Kuczera
Mark Thyer

Working Document 02/3

The work reported here forms part of CRC Project 5.2 - National Data Bank of Stochastic Climate and Streamflow Models - of the Climate Variability Program. The literature review (CRC Technical Report 00/16) carried out as part of the project recommended an autoregressive time series model or the Hidden State Markov (HSM) model to generate annual rainfall data.

In this working document, these two models are applied to 44 stations located in various parts of Australia. The performance of the models is assessed using a number of basic and other statistics. Based on this, recommendations are made as to the appropriate model for the generation of annual data.

Copies are available through the Centre Office for $22.00.

in an industry user's environment. In addition to their agreed contribution to the CRC, both Melbourne Water and Brisbane City Council staff facilitated testing of the MUSIC prototype. In partnership with the research team the industry staff also defined further development requirements. Through this process a potential adoption gap was bridged.

Road testing of software

The MUSIC 'road testing' process undertaken by Brisbane City Council and Melbourne Water staff totalled hundreds of hours. In addition to using the beta version of MUSIC in an industry context, a users' forum was held where research teams and end-users could exchange ideas about how to improve the model's capability to meet the industry needs. Brisbane City Council and Melbourne Water staff also engaged a wide sample of colleagues inside and outside of their organisations to test the beta version of MUSIC for industry use. From early on, industry staff were planning for the application of MUSIC throughout their own organisations and in others they worked with.

Industry motivation

What motivated these two organisations to invest over and above their original agreement to develop MUSIC into an operational product? Key industry staff could clearly see the benefits that would arise from investing further in the development of this research product. Indeed Melbourne Water and Brisbane City Council are continuing to invest substantial time in reviewing and applying MUSIC. Their efforts continue to improve MUSIC for the benefit of the whole urban stormwater management industry.

Other CRC products

Whilst not all CRC research products are as discrete and clearly focussed as MUSIC, many products have the potential to benefit from the collaborative relationships that exist within the CRC. I am looking forward to describing more examples in this column as our current set of projects draws to a close and potential adoption gaps are addressed.

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POSTGRADUATES AND THEIR PROJECTS

Leo Lymburner

I graduated from Macquarie University in 1998 with a Bachelor of Science (Honours) in Remote Sensing. Upon graduating I found work at CSIRO in the Environmental Remote Sensing Group, where I spent an enjoyable three years working with Dr Alex Held and other colleagues on airborne and satellite remote sensing projects in various locations locally and abroad.

After three years at CSIRO I felt the urge to take the next step and tackle a PhD. After a series of applications I was offered a PhD scholarship with the CRC by Peter Hairsine, and was happy to join the CRC, having had previous contact with the CRC through Rob Vertessy.

My PhD project is titled "Estimating riparian vegetation functions in the Nogoa catchment of the Fitzroy river basin using remote sensing and spatial analysis" and is supervised by Peter Hairsine, Alex Held and Jeffrey Walker.

The motivation for this comes from the fact that while riparian zone functions are understood, the spatial distribution of these functions remains a gap in knowledge. Remote sensing, G.I.S. and terrain analysis provide tools to address this gap. Information about the spatial distribution of riparian zone vegetation and the functions served by this vegetation will hopefully be used to inform resource management and conservation decisions, and provide useful input into the CRC Toolkit suite of software.

The aim of my project is to map riparian vegetation structure in the Fitzroy Basin using remote sensing imagery. This will combine the vegetation structure with land-use, soil and terrain information to infer the various functions performed by the riparian vegetation. It is anticipated that the project will be complete in May 2004.

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CRC PROFILE

Our CRC Profile for June is:

Graham Jenkins

Hi. As you can see from the title of this article, my name is Graham Jenkins and I am a researcher in the CRC for Catchment Hydrology. I am based in the School of Environmental Engineering at Griffith University, where I am a senior lecturer in environmental fluid mechanics and hydraulics.

It seems like a long time ago now that my career began. 1975 was the year and flairs were everywhere, as far as the eye could see. Living in a city like Newcastle, and attending a technical boys high school, it seems I was destined to find a career in some form of engineering. So when the opportunity arrived I left high school and plunged headlong into the roller coaster ride of engineering. In reality, I started work in an office in a world full of flairs, body shirts, platform shoes, four-inch wide ties and disco music.

The first part of my journey to where I am now was as a drafting assistant in the Hunter District Water Board in Newcastle NSW. I had a great time at the Water Board, where I learned a lot of practical skills that have helped me throughout the rest of my career. Probably the most important thing about my time at the Water Board was that my managers always encouraged me to improve and develop my skills. By the time I had left the Water Board I had been involved in most areas of the Board's operations and even spent a couple of months working on site with a water supply maintenance gang.

At the end of my TAFE course in Civil Engineering I was given the opportunity to study part time at Newcastle University in the Bachelor of Engineering program. Part-time study was a bit of a drag, so after two years I transferred to a cadetship at the Board and completed my degree in full-time mode. I remember starting my Civil Engineering degree wanting to design and build bridges and other things structural. However, I was lucky enough to have Dr Wally Field as a lecturer in hydraulics and fluid mechanics and by half way through my degree I had realised that all the fun things were in water engineering.

Following the completion of my undergraduate degree I worked for about a year in consulting engineering companies in Sydney. Mostly the work involved the design of various bits and pieces in wastewater

NEW 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 models 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.

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treatment plants. As my interests lay in hydrology and hydraulics, I decided to continue my studies with a PhD in civil engineering hydraulics. I was lucky enough to get a job as a Senior Tutor in the Department of Civil Engineering at Monash University. Assoc Prof. Bob Keller was my supervisor, and I worked on the development of a model to predict two-dimensional flow characteristics in natural river and floodplain systems.

Monash University was a great place to study for a PhD at the end of the 80's. There was a great group of postgraduate students, and there was always a lively discussion in the lunch room about anything and everything. To my surprise, I even found myself playing the Friday afternoon indoor cricket, thanks to the Sri Lankan contingent. I was especially lucky because as a Senior Tutor I also got the chance to teach as well as do my research.

Following completion of my PhD I piled up the truck and headed north to sunny Queensland, where I worked for a short while at another consulting engineering company. It wasn't long before the call of university life became too strong and I took up a position as a lecturer in the School of Civil Engineering at Queensland University of Technology. During my time at QUT I focused heavily on teaching. I was involved in teaching all of the water engineering subjects, some engineering design and professional practice subjects. The School of Civil Engineering had a great group of dedicated academics, and I was fortunate to have been able to work with them.

Towards the middle of 1999 I got itchy feet once more and moved further up the coast to take up a position as hydraulics engineer at Maroochy Shire Council. The sunshine coast was a great place to live, and working at Maroochy Shire Council gave me some good insights into the application of water engineering in small catchments. This experience also highlighted the importance of environmental hydraulics within urban catchments. It was also clear that the urban engineering profession were poorly equipped to address many of the important issues related to environmental hydraulics in urban catchments.

And so in early 2000 I moved back to academia to work at the School of Environmental Engineering at Griffith University. One of the attractive aspects of this position was that I was able to work with the CRC for Catchment Hydrology in the Urban Stormwater Quality Program. My work at Griffith University has centred on getting a better understanding of the effects of hydraulic characteristics in wetland systems. In particular I have been investigating the impact of fringing vegetation on the hydraulic efficiency of wetlands, using the two-dimensional model I developed in my PhD. I have also been involved as one of the development team for the MUSIC software, which has been a rewarding experience for me.

One of the best parts of working at Griffith University is the chance to work with a diverse group of academics. Although our school is full of the typical mix of engineers, we are part of the Faculty of Environmental Studies that contains a mix of scientists, engineers, planners, mathematicians, sociologists and economists. I have found the interaction that occurs within the faculty to be a great benefit in my research and my wider professional development.

The only question left unanswered now is "Where to from here?". I am not too sure about that. However, my life up to this point has taught me that the future is a great adventure. I suspect that I will always have something to do with teaching, simply because I really enjoy working with students. There is truly no better reward than to have a student say, "Now I understand". I am also sure that I will continue to develop software for the solution of problems in environmental hydraulics and hydrology.

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WHERE ARE THEY NOW?

Report by Michele Akeroyd

I initially moved to Canberra in April 1997 to take up a PhD scholarship with the CRC for Catchment Hydrology, which I started in June 1996 based in Adelaide. I finally submitted my thesis in January 2002 and am still living in Canberra.

My PhD research investigated the potential for using the stable isotopes of tree rings to reconstruct tree water-use strategies of riparian vegetation. While the results of this study were often not clear, especially at the catchment scale, this research has provided a solid base from which further development and application of this technique can be targeted in order for future analyses to be successful.

Like most PhD's mine was filled with many challenges, although I am responsible for causing the biggest of those challenges. They would have to be the birth of my children, Jack and Chloe, and my brilliant idea of starting full-time employment before submitting my thesis. Hence the delay in submitting my thesis...... It certainly was a challenge combining a PhD with full-time employment and a young family.

For the last two and a half years of my PhD studies I worked full-time in the Natural Resource Management Policy Division at the Commonwealth Department of Agriculture, Fisheries and Forestry - Australia (AFFA). I worked on the implementation of the Great Artesian Basin Sustainability Initiative and a range of Natural Heritage Trust (NHT) programs. I then moved to a more challenging role in the national resource management (NRM) monitoring and assessment area of the NRM Policy Division at AFFA. Some of the key projects I worked on in this team included AFFA coordination of the review of the performance of the Natural Heritage Trust, developing a final evaluation strategy for the first phase of the NHT, and then the development of national monitoring and evaluation strategies for the National Action Plan for Salinity and Water Quality, and the extension of the NHT.

I have since left AFFA and have recently taken up a position at the Murray-Darling Basin Commission as a Program Officer for the Basin Salinity Management Strategy. The technical knowledge and experience gained from my association within the CRC for Catchment Hydrology and policy experience from AFFA has really given me a solid grounding to assist the implementation of the Basin Salinity Management Strategy.

It is certainly a very exciting and challenging time for natural resource management, particularly salinity, and I am really enjoying being an active part of the development and implementation of long-term strategies to reverse the trends of land degradation.

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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

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