NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 88 OCTOBER 2000

A NOTE FROM THE DIRECTOR

Professor
Russell Mein

Inside...

ANNUAL REPORTING

The Annual Report for 1999/2000 of the CRC has now been printed, with copies being sent to most readers of *Catchword*. You can distinguish it from others by its (predominantly) blue cover, the colour prescribed for this year by the CRC Secretariat. The more discerning readers will note the new logo and expanded list of Parties on the back cover.

It is when you open the Report and start reading that you realise that this is the first year of a new CRC. The main focus of the activity in the reporting year has been on new projects. To supplement this, there is an outline of some residual project work from the first CRC for Catchment Hydrology, and of the activities of several postgraduates who are completing research programs.

A planning year

It has been a year of planning. We had done the preliminary work in 1998 with scoping workshops of industry and research leaders at the national level in land and water management; these gave us the main research directions for a new CRC. To develop the bid, we used facilitated 'brainstorming sessions' of middle level managers to define a set of project abstracts to describe research which matched user needs and researcher capabilities. The further planning in 1999/2000 was needed to produce an integrated set of projects that made the best use of the CRC's personnel and other resources, met the interests of the Parties, and was within our budget.

The CRC Board was closely involved, even scheduling an extra meeting to help reach consensus on the initial round of projects. Project technical advisory groups (TAGs) were convened to flesh out the project abstracts into documents (Project Agreements) setting out the objectives, methodology, milestones, outcomes, communication/adoption plan, personnel and budget. The Agreements set out who is expected to do what, and by when, and are signed off by each Party involved in the work.

Particular emphasis was placed on collaborative research with the CRCs for Freshwater Ecology, and Coastal Zone. There are extra overheads in working out arrangements for collaborative projects with other groups (meetings, matching of timelines, etc.), but we believe they are far exceeded by the benefits. Apart from the obvious synergies of collaboration from sharing resources, the outcomes from combined work are potentially far more useful for managers who have to apply them. Several of our Board members are members also of these other CRCs, and strong proponents of joint projects.

Highlights for 1999/2000

A real highlight for me was the establishment of an integrated set of research projects for the new CRC. This was quite challenging for all involved in the planning process, for it meant specifying the linkages and transfer of information between projects (and contingencies if there were problems!), in addition to the usual project activity. The enthusiasm of CRC participants at the Mt Buffalo workshop for 'taking on' the group of projects was, for me, immensely rewarding.

The inclusion of the socio-economic dimension in our research program has been another highlight. In resource issues, socio-economic aspects are vitally important for implementation of research outcomes on large catchments. Program Leader John Tisdell and his team have worked hard to add their socio-economic skills to projects on sustainable water allocation. (Readers will know, from media reports, what a hot political issue this is, with environmental, social, economic, and resource tradeoffs being involved).

There were many specific highlights. The recently released two-volume 'Rehabilitation manual for Australian streams' (jointly published with LWRRDC) is a great credit to Ian Rutherfurd and his team. Glen Walker's group is also to be congratulated for their set of manuals on salt disposal basins.

Our industry seminars again were much valued by land and water managers; those on constructed stormwater wetlands (Tony Wong et al) and managing sediment sources and movement in forests (Jacky Croke et al) have drawn large audiences.

Need a copy?

I could go on, if only to mention all the others in the CRC who have contributed so much this year, but space precludes that.

To catch up with our achievements and plans, I urge you to read the annual report. If you don't have a copy, and would like one, please contact Virginia Verrelli on 03 9905 2704, or email her on virginia.verrelli.eng.monash.edu.au.

It's a good read.

Russell Mein
Tel: (03) 9905 4980
Email: russell.mein@eng.monash.edu.au

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

CRC PUBLICATIONS LIST

Reports, videos and software, available from the CRC, are listed in our Publications List,

Copies of the Publications List are available on request from the Centre Office on 03 9905 2704 or can be downloaded from the CRC website at

www.catchment.crc.org.au

All prices listed include GST, postage and handling.

PROGRAM 1 — Program Leader: ROB VERTESSY

PREDICTING CATCHMENT BEHAVIOUR

Report by Robert Argent

Project 1.1: Development of a catchment modelling toolkit

Frameworks and toolkits: the future of environmental modelling

What is a toolkit for catchment prediction modelling? In this month's article we preview a paper that will be presented at Hydro2000, and discuss some of the ins and outs of modelling frameworks and toolkits. Firstly, though, a quick review of what Project 1.1 is about and why we are doing it!

Project 1.1 - Background and purposes

Essentially, the problems that many of us have with some current catchment models can be summed up in the phrase "water quality Model XXXX is not too bad, but I wish I could change the routing procedure". The problem here is that the model is seen as an immutable combination of routines (ie a solution looking for a problem) rather than the result of a process that selects and combines appropriate routines to fit the modelling solution to a given problem situation.

A more useful approach, and one which is supported by modern software engineering practice, is to construct the various routines as core modules which can be individually selected and combined to form new and appropriate applications for each different problem. When housed within a flexible modelling framework, and complimented by support modules for data handling, visualisation, documentation, and analysis, a toolkit for catchment prediction modelling can be provided. This is the future of environmental modelling!

Modelling approaches

To attack this problem we are pursuing a number of threads. User surveys have highlighted for us the modelling processes that we need to focus upon, the kinds and styles of modelling that are done by modellers within the CRC for Catchment Hydrology, and the models that people are using, and why (Thanks to those who took the time to respond to our queries). We are also reviewing the modelling framework developments going on around the world, and investigating the special needs of modelling in catchment hydrology.

In one way, any modelling activity can be treated as a transformation of data (input) into data (results) through processing by core modules; ie:

input data → core modules → results (data)

Some challenging issues

Unfortunately, development of a modelling toolkit is not as easy as we like to make it sound! In selection and development of a framework to support this transformation, each of the three elements (input, modules, results) has a range of issues that must be addressed. Some of these are hard core software engineering and programming issues, and others are issues to do with the likes and dislikes of programmers and people running applications.

Issues associated with all three elements include the provision of training and documentation, while each of these three elements has issues that include:

- Input data
  Generation, gap filling, storage, access, metadata, visualisation, analysis, selection engine
- Core modules
  Selection engine, review, open source, authentication, specification, user help, parameters, uncertainty, reporting
- Results
  Reporting, visualisation, analysis, graphs, tables, scenario comparison and decision support

Key ideas

Each of the issues above could be the separate topic of a *Catchword* article (hmm, there's an idea!), but for the moment I will just touch lightly upon a few key ideas.

- Documentation
  Documentation must be considered at all levels in a good modelling framework, covering such diverse elements as documentation of code, version control on modules, recording of review and authentication processes, and provision of information relevant to the selection of appropriate modules for particular problem situations. At the point of running applications, documentation also covers recording and reporting on the data sets, modules and parameters used in various application runs, and provision of user help and training documentation. The ubiquitous nature of HTML, widespread adoption of WWW browser technologies, and the flexibility and functionality of the EXtensible Markup Language(XML), provide some excellent indications of future directions in document development and handling. It is envisaged that a browser-style operating environment for a modelling toolkit would be one which would be supported technically for a long time, and which would also have strong user appeal and instant familiarity. All of the documentation needs listed above lend themselves to this style of environment.

- Data access, storage, gap filling and generation
  Almost all core modules use data, and many use similar data, so good data handling is essential. Data are becoming increasingly available from remote sources, and tools will be required that can automatically download and manage data. Alternative approaches to handling data from remote sites also need to be addressed, as there are many options available. Almost all data have gaps, and tools will be required to provide intelligent infilling of data sets. Generation of stochastic data sets, and creation of spatial coverages, are essential in many catchment modelling applications, so support modules will need to be provided for these.
- Specification, notation, authentication and peer review
  One of the fundamentals of modular development is expression of the module in such as way that others can understand it, using a defined specification and notation system. There are a number of notation approaches available, ranging from flowcharts and pseudocode to almost code-like notation languages, such as the Unified Modeling Language (UML). A key to use of such a system in catchment modelling is finding a system that people can easily use and understand. Checking and verification of module code must also be considered.
- Selection engine for data and modules
  One of the frustrations expressed by hydrologists arises from the plethora of models, modules, and algorithms that appear to do similar things. For example, in routing flows, the available options allow treatment at different spatial and temporal scales, and different levels of complexity. One of the tools thought essential to the wider operation of a modelling toolkit is an "intelligent selection engine" that would guide users through selection of appropriate modules, given a range of options for using and assuming input data and parameters.

An invitation

Thus, there are many issues that we are considering in Project 1.1. I invite those who are attending Hydro2000 to come to our session and hear some more (and ask me some long questions!)

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

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Jon Olley

OSL and the sand-slug

I feel refreshed after spending a week in the field with Bill Young, Ian Rutherfurd and Danny Hunt, looking at the sand-slug in Creightons Creek, near Euroa, Vic. We are hoping to develop an understanding of the way sand is moving through the system, building on the previous work by Rebecca Bartley, Jennifer Davis and others. We collected sediment cores, up to 3m in length, from along the sand-infilled sections of the creek. We were able to do this using PVC tubes and some fancy core extraction devices built by Danny Hunt. A total of 18 m of cores were extracted and returned to the Canberra laboratory, where we intend to examine the Optically Stimulated Luminescence (OSL) characteristic of the sand grains. Many of you will not be familiar with OSL, hopefully the following will shed some light on the matter.

Background to Optically Stimulated Luminescence (OSL)

OSL can be used to estimate the time that has elapsed since buried sediment grains were last exposed to sunlight. Optical dating makes use of the fact that sunlight releases electrons from light-sensitive traps in the crystal lattice of grains of quartz and feldspar. The release of trapped electrons by light stimulation resets the OSL signal to zero. This resetting is commonly referred to as bleaching. When the grains are buried and unexposed to sunlight, they begin to accumulate a trapped-electron population due to the effect of ionizing radiation emitted by the decay of radionuclides present in the deposit. Some of this natural radioactivity may be derived from within the quartz or feldspar grains, but the radiation dose is mainly derived from the surrounding material. If the flux of ionizing radiation is constant, then the burial time of the grains can be determined by measuring the dose stored in the grains, divided by the flux of ionizing radiation (the dose rate); such that:

Burial-time (years) = Burial-dose (Gy)/Dose Rate (Gy year $^{-1}$).

The dose-rate is a measure of the strength of the ionising radiation to which the mineral is subjected.

Adjustments needed for standard OSL tehniques

In circumstances where sediments did not receive adequate exposure to sunlight prior to deposition, standard OSL dating techniques over-estimate the time since burial. This is because contamination by poorly-bleached grains prevents the accurate measurement of the dose in the well-bleached proportion of the sediment.

PROJECT DETAILS ON OUR WEBSITE

The CRC has recently published 'project description sheets' for each research project on the CRC website.

The pages (also available as pdf files) give details of research objectives, expected outcomes, target problems, key tasks, links, staff involved and contacts for each project.

Click on 'Projects 1999-2002' on our website at www.catchment.crc.org.au

NEW CRC SOFTWARE

AQUACYCLE

Aquacycle is a daily urban water balance model which can be used to investigate the use of locally generated stormwater and wastewater as a substitute for imported water. Dr. Grace Mitchell developed Aquacycle during her postgraduate studies.

The Aquacycle includes the CD-ROM and a complimentary copy of the CRC Industry report 'The Reuse Potential of Urban Stormwater and Wastewater'.

A copy of Aquacycle can be ordered through the Centre Office. Users are requested to sign a User Agreement and a manufacturing and distribution cost of $27.50 applies to orders.

For further information visit www.catchment.crc.org.au/products

PLEASE NOTE: The Aquacycle software is currently only available for IBM compatible computers.

Given the nature of the transport and deposition processes associated with sand-slugs sediments, it is highly unlikely that they will have received sufficient exposure to sunlight to fully-bleach all of the sediment grains at the time of deposition. Consequently, in this study we will use a recently developed OSL protocol to determine the dose in only the well-bleached proportion of the sediment, and thereby estimate the true time that has elapsed since deposition. This usually involves measuring the dose in individual grains.

Developing sand transport models

Knowing the deposition time and the bleaching characteristics of the sediments will tell us a lot about the history of sand transport along the Creightons creek system. We will also attempt to model sand transport based on measurements (yet to be made) of channel cross sections and slopes together with the available flow and rainfall data. The results of the modelling and the dating will be compared to refine the modelling. As we develop and refine these relatively simple models and experimental techniques we hope to apply them in the more complicated, much larger, Murrumbidgee catchment.

Impacts of coarse-grained sediment on channels

Deposition of coarse-grained sediment has significantly altered the form and hydrology of many channels. This material is typically transported as bed-load. In southeastern Australia the extensive gullying which followed European settlement released large quantities of coarse-grained material into the channels. This sediment is migrating through the channel network, filling pools and significantly altering the channel habitat.

Predicting sand-slug migration

Although adequate theory and field data exists to predict bed-load transport associated with the migration of individual dunes and ripples, little is known about the conditions required to mobilise the massive sand slugs that have formed in many Australian rivers.

New OSL based techniques that we are developing offer an opportunity to investigate these processes and to determine what flow energies are required to cause migration.

We hope this work will produce a better understanding of when bed-load transport is occurring in large river systems. It will enable the prediction of major bed-form migration rates and identify what flow energy is required to trigger major changes in bed and channel form.

References

For further information on OSL and its application to dating of fluvial material, the following reference are good starting points:

- Aitken (1998) An Introduction to Optical Dating, Oxford Univ. Press, Oxford.
- Olley, J.M., Caitcheon, G., and Roberts, R. (1999). The origin of dose distributions in fluvial sediments, and the prospect of dating single grains of quartz from fluvial deposits using OSL. Radiation Measurements, 30, 207-217

Jon Olley
Tel: (02) 6246 5826
Email: jon.olley@cbr.clw.csiro.au

PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Water Management in Australia: (Historical Background for Project 3.2)

(This article is a synopsis of a paper submitted to the Australian Water Association for publication in "Water". Interested readers are encouraged to seek out the fuller article in that journal)

Water management in Australia has changed considerably with time, and particularly over the last twenty to thirty years. When making decisions concerning water supply, water authorities now need to consider not just hydrological and system constraints, but also the social and regional economic consequences of their decisions. COAG reforms have brought with them questions of economic efficiency and equity in managing a public good, not just better management of water supply systems.

Hydrology/engineering emphasis

For most of the first two hundred years of European settlement, water resource policies, like those relating to other resources, were focused on exploitation to promote economic and demographic growth, and employment generation. The role of the water authority was to engineer dams and supply systems to capture and promote the use of available water. They were not directly involved in the strategic planning or implementation of national or state economic or social policies.

The relevant legislative arrangements in Australia date from 1886, and established the principle that streams were public property, giving the States control over the water. A system of administrative allocation of rights to water was also instituted, managed by public water authorities in each State.

On the basis of these institutional arrangements, State governments became developers of water supply infrastructure such as dams, and developers and owners of large-scale urban and rural supply schemes (including irrigation).

Changing attitudes

In the 1980s water management in Australia began to consider broader objectives. No longer do water authorities look solely to the construction of bigger dams to solve water issues; rather, they examine options of improving the allocation of existing water entitlements in conjunction with environmental and social policy objectives. Their objective is seen as promoting efficiency and equity of water allocation while protecting the environment.

By 1990, water authorities were compelled to address issues and policies related to the management of water resources in a mature water economy. The incremental cost of water supply was sharply increasing. As most of the available and economic water resources had been exploited, and the cheap dam sites used, the opportunity cost of capital for water resource development had risen to historically high levels; ageing infrastructure was contributing to increased operation and maintenance costs, and pressure for expenditure on replacement. Further, the demand for water resources was increasing in scale and diversity, particularly demand for environmental objectives, and concern for improved quality of supply. Conflict was growing, both between potential uses, and between the old developmental objectives and the newer economic and environmental objectives, but being played out within institutional settings geared to resource expansion rather than optimal allocation of a scarce resource. Finally, awareness was growing of the severity of environmental degradation, its irreversibility in some cases, and the consequences including declining quality of the resource.

Current Issues

The water authorities are now involved in managing these conflicting demands on the use and distribution of water within a period of institutional reform - be they economic, environmental or social. They have met their changing role, and acquired the new knowledge base through recruitment, reskilling existing staff and commissioned consultants for specialised tasks.

Meeting the broadening and changing role of water management in Australia will be among the greatest challenge facing water authorities in the future. The Sustainable Water Allocation Program of the CRC aims to assist them in this challenge.

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

NEW CRC PROGRAM SOFTWARE

Extreme Design Rainfalls for Victoria

The crcforge-extract computer program has been produced to facilitate the extraction of rare to extreme rainfalls from the (at present, Victorian) database, and to present the information in forms needed for hydrologic design.

For further information see our website at www.catchment.crc.org.au / news

To obtain a copy of crcforge-extract contact Virginia Verrelli at the Centre Office on 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au

CANBERRA TECHNICAL SEMINAR

IRRIGATOR ATTITUDES TO WATER TRADING IN THE GOULBURN-MURRAY CATCHMENT, VICTORIA

by

Dr John Tisdell
Program Leader
CRC for Catchment Hydrology
Griffith University

Thursday 2 November 2000

TIME
10.45 for an 11.00am start

Tea/coffee on arrival

at
Conference Room
CS Christian Laboratory
CSIRO Land and Water
Black Mountain Laboratory
(Clunies Ross Street, Acton)

For further information contact Tanya Jacobson on 02 6246 5746

PROGRAM 4
URBAN STORMWATER QUALITY

Program Leader
TONY WONG

Report by Tim Fletcher & Tony Wong

Quantifying ecosystem responses to catchment urbanisation; a collaborative approach to a complex problem

The name of Program 4, Urban Stormwater Quality, gives a clear indication of its aims. However, improvement of urban stormwater quality is really just the means to the desired end; improved ecosystem health.

Hydrologic and water quality impacts

Much research has been undertaken to understand the impacts of catchment urbanisation on hydrology and water quality. Similarly, recent research efforts have resulted in the development of stormwater improvement facilities (e.g. wetlands, gross pollutant traps, infiltration systems) to help ameliorate these impacts.

Ecological impacts

There remains, however, a significant gap in our understanding of the subsequent impacts of urbanisation-induced hydrology and water quality changes on ecosystem health. Without this understanding, we are limited to developing stormwater strategies based on hydrologic and water quality objectives only. What is needed is the ability to develop strategies that are based directly on measurable ecosystem health objectives.

Targeted project activity

These ecological issues are targeted in CRC Project 4.1, through a major activity entitled "Quantifying Ecosystem Responses to Catchment Urbanisation" (Activity 4.1.3). This work therefore has the following objectives:

1. To improve our understanding of the impacts of urbanisation on ecosystem structure and function,
2. To improve our understanding of the impacts of stormwater management facilities on downstream ecosystem health,
3. To allow the establishment of stormwater quality and hydrology criteria which reflect the impacts on aquatic ecosystems.

Inputs to Decision Support System

Answering the questions contained within these objectives will feed into the CRC's Urban Stormwater Management Decision Support System (DSS). The DSS will help urban waterway managers to set priorities and assess stormwater strategies, and to design improvement facilities.

This broader approach will ensure that stormwater management strategies are based on ecological objectives (which may be risk-based), rather than simple water quality criteria, which may not reflect the highly dynamic interactions in ecosystem responses to stormwater inputs.

Need for collaboration

Understanding the links between urban stormwater and ecosystem health is a complex task, however, and requires the collaboration of scientists across a wide range of disciplines.

Activity 4.1.3 is therefore built on extensive collaboration with the CRC for Freshwater Ecology (Project D1 – "Urbanisation and the Ecological Function of Streams", and Project B3 – "Show-casing Restoration"), and with CRC for Catchment Hydrology Program 6 - River Restoration.

Freshwater Ecology CRC Project D1

The CRC for Freshwater Ecology's Project on "Urbanisation and the Ecological Function of Streams" is led by Dr. Chris Walsh. This project will assess the effects of catchment imperviousness, and drainage infrastructure types on urban waterway health. In particular, ecosystem structure, and nutrient dynamics will be assessed.

A spatial database of catchment characteristics (e.g. imperviousness, drainage connectivity, rainfall, topography, geology) will be constructed, and used to measure relationships with ecosystem function.

Catchment Hydrology CRC approach

Our CRC's Urban Stormwater Quality group will use the spatial database to develop probabilistic (risk-based) models of streamflow and water quality. These will be based on intensive monitoring, and will be incorporated into the CRCFE's ecosystem models.

Case study catchments for monitoring are being jointly chosen by the CRCs for Catchment Hydrology and Freshwater Ecology. These catchments will reflect a range of urbanisation impact levels.

Measuring treatment impacts

Once the relationships between urbanisation and ecosystem health are established, the impacts of treatment measures will be assessed. For example – what impact does the retrofitting of a water quality wetland in an urban retarding basin (*Figure 1*) have on the downstream ecosystem?

Figure 1. Wetland retrofitting of an urban retarding basin - an opportunity for monitoring impacts on downstream ecosystem health.

This component of the project will be undertaken in collaboration with Dr. Ian Rutherfurd (CRC Program 6 – River Restoration) and Dr. Peter Breen from the CRC for Freshwater Ecology. Selection of study sites is a key component of the project.

Outcomes from project activity

The main outcome of this work will be improved design guidelines for stormwater treatment measures, based on ecosystem health requirements, and taking into account the stochastic, or risk-based, nature of urban stormwater hydrology and quality.

It is hoped for example, that the models will indicate the probable frequency of exceedance for specified flow or water quality criteria, and use this information to predict the impact on receiving ecosystems. This recognises the ability of ecosystems to recover from impacts, subject to their magnitude and frequency.

Improved stormwater management tools

Delivery of the Urban Stormwater Management Decision Support System (DSS) gives the CRC Urban Stormwater Quality Program a strong focus on user-friendly outputs of its research.

The results of the Project 4.1 work on ecosystem responses will be fed directly into the DSS, so that the complex ecosystem models become easily applicable tools. The aim is to improve the design and priority-setting of stormwater treatment measures.

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

NEW CRC TECHNICAL REPORT

WATER SENSITIVE ROAD DESIGN - DESIGN OPTIONS FOR IMPROVING STORMWATER QUALITY OF ROAD RUNOFF

by

Tony Wong
Peter Breen
Sara Lloyd

Report 00/1

This joint publication with the CRC for Freshwater Ecology investigates opportunities for incorporating stormwater quality improvement measures into road design practices for protecting aquatic ecosystems.

Copies of the report are available from the Centre Office for $27.50 (includes postage and GST).

Please phone Virginia Verrelli on 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au

QUESTION FOR THE CRC?

The CRC website Forum is now available for you to use at www.catchment.crc.org.au/forum

The Forum aims to assist you in understanding the CRC's research outcomes and their application by providing a direct communication link to the resources of the CRC for Catchment Hydrology.

You are welcome to use it anytime to answer your questions or to post requests for information.

Information on how to use the Forum is given on our website.

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
TOM McMAHON

An analysis by Tom McMahon and Sri Srikanthan

How rare is the present drought in Victoria?

Data used

To answer the question 'how rare is the present drought in Victoria', we have analysed the annual rainfall records for twelve stations in Victoria (*Figure 2*). Except for Irymple, Seaspray, Warburton and Penshurst, the stations are considered by the Bureau of Meteorology to have high quality data. The stations were also chosen to provide a broad coverage of the state as well as having long records. All have more than 100 years of data except Irymple and Natimuk. Details are given in Table 1. The analysis reported below forms part of a larger study that we are carrying out within the CRC Project 5.2: 'National data bank of stochastic climate and streamflow models'.

Outline of analysis

To estimate the rarity of the present drought we chose to estimate the average recurrence interval (in years) of five periods of rainfall namely July 1999 – June 2000, July 1998 – June 2000, July 1997 – June 2000, July 1996 – June 2000 and July 1995 – June 2000 i.e., the most recent 1, 2, 3, 4 and 5 consecutive years rainfall. To do this we assumed that annual rainfalls were either Normally or Gamma distributed as appropriate and used the analytical technique described in Srikanthan & McMahon (1986). (Only two of the 12 stations were considered to have Normally distributed annual rainfalls - Wilsons Promontory and Seaspray). This technique allows us to estimate the recurrence interval of long hydrologic events. The results of the analysis are presented in Table 2.

Interpreting recurrence intervals

We can interpret the average recurrence intervals in Table 2 in the following way. For example, for Natimuk the 4-years rainfall from July 1996 to June 2000 is shown as having a recurrence interval of 65 years. By this we mean that over a long period say 1000 years, we would expect approximately 15 (=1000/65) 4-year consecutive periods of rainfall equal to or less than that recorded for the July 1996 to June 2000 period.

Table 1: Rainfall stations in study

Station number	*Station name*	*Start of record*	*Length of data (years)*	*Latitude*	*Longitude*	*Mean annual rainfall (mm)*	*Coefficient of variation of annual rainfall*
76015	Irymple (Arlington)	1908	92	34.23	142.15	279	0.37
79036	Natimuk	1907	93	36.75	141.93	445	0.20
80009	St Arnaud	1887	113	36.48	143.35	443	0.26
82001	Beechworth (composite)	1876	124	36.37	146.71	963	0.24
84030	Orbost	1883	117	37.63	148.46	852	0.23
85073	Seaspray	1898	102	38.32	147.18	599	0.22
85096	Wilsons Promontory (Lighthouse)	1873	127	39.13	146.42	1054	0.16
86117	Toorourrong Reservoir	1892	108	37.48	145.15	803	0.19
86121	Warburton	1892	108	37.76	145.69	1337	0.16
87043	Meredith (Darra)	1875	125	37.82	144.15	683	0.18
88034	Kilmore (Assumption College)	1883	117	37.30	144.94	726	0.23
90063	Penshurst (PO)	1882	118	37.88	142.29	721	0.17

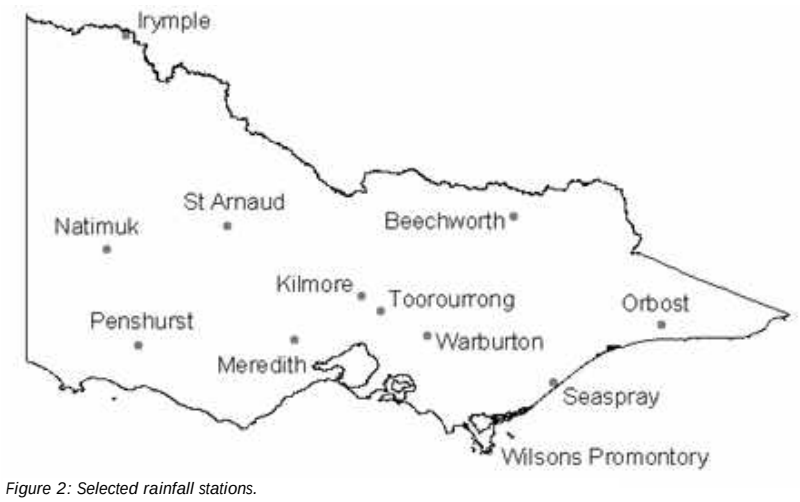

Figure 2: Selected rainfall stations.

Table 2: Average recurrence interval (in years) of recent low rainfall periods in Victoria

Station number	Station name	July 1999 – June 2000	July 1998 – June 2000	July 1997 – June 2000	July 1996 – June 2000	July 1995 – June 2000
76015	Irymple	1	2	4	5	6
79036	Natimuk	5	12	27	65	61
80009	St Arnaud	2	4	6	8	8
82001	Beechworth	1	2	4	5	6
84030	Orbost	2	6	7	9	9
85073	Seaspray	4	4	7	11	8
85096	Wilson's Promontory	3	8	12	8	6
86117	Toorourrong	2	3	9	21	11
86121	Warburton	2	4	12	15	9
87043	Meredith	4	7	21	41	13
88034	Kilmore	1	3	7	13	9
90063	Penhurst	5	12	35	38	51

LEGEND

Recurrence interval 10 to 25 years

Recurrence interval greater than 25years

Findings

In Table 2 we have two groups of recurrence intervals - rainfall periods in which the average recurrence interval is 25 years or more and an interval of 10 to 25 years. Interestingly, for the three sites Natimuk, Meredith and Penshurst having the exceptionally dry periods over the past four years, each recorded four consecutive years of lower rainfall than the present drought. At Natimuk, this occurred from July 1982 to June 1986, at Meredith from July 1941 to June 1945 and at Penshurst from July 1911 to June1915.

The analysis suggests that the north and north-east of Victoria and East Gippsland have escaped much of the extreme severity of the recent drought.

A CRC report covering a more inclusive analysis will be published in due course.

References

Srikanthan, R. & T.A. McMahon (1986): Recurrence interval of long hydrological events: application to low flows. Journal Hydraulics Engineering ASCE 112 (6), 518-538.

Tom McMahon
Tel.: (03) 8344 6641
Email: t.mcmahon@civag.unimelb.edu.au

BRISBANE TECHNICAL SEMINARS

PERSPECTIVES ON THE MODELLING TOOLKIT

SPEAKER:
Assoc.Prof. Roger Braddock
Griffith University

Wednesday 15 November 2000
Start 1pm (until 2pm)

at
Griffith University
Nathan Campus,
Room: E2N 0.05.

For further information contact
Mary-Lou Clarke on
tel: 07 3875 5394

AN ENVIRONMENTAL MANAGEMENT SUPPORT SYSTEM FOR THE SOUTH EAST QUEENSLAND REGION

SPEAKERS:

Dr Rob Vertessy,
Joel Rahman, and
Sue Cuddy
CSIRO Land and Water;

Dr Francis Chiew and
Dr Phil Scanlon
The Unversity of Melbourne;

Dr Fred Watson
California State University, Monterey Bay.

Monday 4 December 2000
Start 9.00 am (until 11.00 am)

Brisbane Venue to be advised.

For further information contact
Mary-Lou Clarke on
tel: 07 3875 5394

CRC WORKSHOP

HYDROLOGY AND HYDRAULICS FOR FLOODPLAIN MANAGERS

Workshop No. 4 - Design of Flood Mitigation Measures

The fourth workshop in this successful series will be held at Monash University during 9-10 November 2000

More information about the workshop program is available from Virginia Verrelli at the Centre Office on tel: 03 9905 2704.

PROGRAM 6 RIVER RESTORATION — Program Leader IAN RUTHERFURD

Report by Lindsay White

Contributions to aid the design of effective fishways

Background

Until about fifteen years ago, most water management agency staff thought that fishways - structures to allow migrating weirs past instream obstructions (eg. weirs) - were inherently ineffective (even 'white elephants!') for Australian fish.

Research over the last fifteen years, particularly by NSW Fisheries and agencies in Queensland, has shown that many of the 190 or so species of Australian freshwater fish are migratory, and that some types of fishways can effectively pass native fishes. In fact, the fishway on the Torrumbarry Weir (River Murray, near Echuca) has been described as a 'spectacular success'.

Factors leading to fishway effectiveness

So, what are the key success factors with regard to the design of effective fishways? I would suggest that they include:

1. The ability to predict the hydraulics throughout fishways for a wide range of operational conditions;
2. Understanding lifecycles of native fish, and in particular triggers to migration (eg. flow and/or water temperature), and the size classes and time that they tend to migrate;
3. Understanding how fish find the entrances of fishways;
4. Understanding any behavioural or physiological characteristics that may curtail movement of migrating fish through the fishway, and in particular, understanding the response of fish to different hydraulic conditions within the fishway (eg. peak velocities, turbulence); and
5. Adequate understanding of structural aspects – for eg. rock sizes that will be stable in rock ramp fishways for a range of hydraulic conditions.

Information for fishway design

Although the wide range of attributes of native migrating fish and hydraulic conditions within different types of fishways make the design of effective fishways a challenge, I think that effective fishways can be designed for Australian fishes if there is adequate informed input from biologists, structural engineers, hydraulic engineers, hydrologists and river operators. The CRC's fishways project is to provide more information into each fishway design process. It may also provide considerable cost savings in some instances, particularly given that the construction costs of fishways can be in the order of $100 000 per vertical metre.

This information on fish passage through fishways will be gained by activities including:

1. Interaction with prominent international researchers;
2. Physical model studies of the hydraulic attributes of different kinds of fishways;
3. Detailed measurements of hydraulic attributes of existing fishways;
4. Observations of fish within fishways using video technology (and subsequently associating this with hydraulic conditions);
5. Association of fish species and size classes passing through the fishway with different potential triggers of migration; and
6. Numerical modelling of some fishway types.

Links with international researchers

I was fortunate to spend 6 weeks working in Canada with Professor Chris Katopodis, a prominent researcher on fishways from the Department of Fisheries and Oceans (Professor Katopodis has been a keynote speaker at many of the international conferences of fishways).

The aims of my trip to Canada were to:

- learn from discussions with Professor Katopodis;
- access the 'Icthyomechanical database' (a database of the swimming characteristics of fish, which includes alien fish found within Australia, and fish of the same family or similar shape to Australian fish);
- access data from past hydraulic experiments using physical models of vertical slot fishways, and any numerical models of these fishways; and
- access government reports and other 'gray' literature.

The trip was a big success, with all of the above aims being met.

Measuring hydraulic attributes of existing fishways

Detailed velocity measurements within a vertical slot fishway are currently being undertaken in Torrumbarry fishway (using an Acoustic Doppler Velocitimeter from The University of Melbourne). An example of some preliminary results is shown in *Figure 3.*

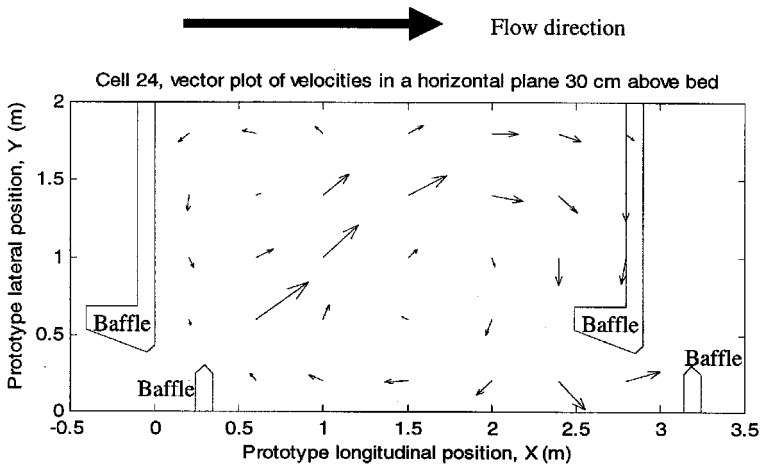

Figure 3 - Plan view of the velocity distribution in a cell of the Torrumbarry fishway. (Note the variability in magnitude and direction of velocity – the fish must burst through (at least some) of the faster velocities and can rest in zones of slower velocity. The longest vector is 1.36 m/s.)

Communicating information

Information on fish passage through fishways will be widely communicated. Proposed dissemination includes:

- Technical manuals;
- Design guidelines;
- A roadshow featuring biologists and engineers;
- At least three theses (including mine); and
- The Third Australian Fishways Technical Workshop (scheduled for 6 and 7 September 2001, to follow the Third Australian Stream Management Conference in Brisbane).

One exciting development with regard to the fishways workshop is that Professor Katopodis has recently accepted an invitation to be the keynote speaker.

Lindsay White
Tel. 03 9905 5022
Email: lindsay.white@eng.monash.edu.au

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Dr Richard Stirzaker
Project Leader
CSIRO Land and Water
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Dr Fred Watson
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EDUCATION AND TRAINING PROGRAM

Program Leader
JOHN FIEN

Report by James Whelan

Toward a new generation of researchers

I have recently come on board with the CRC, joining John Fien in the Education and Training Program. My work is intended to provide for capacity building, education and training needs through activities including supplementary training programs for CRC PhD students. Ultimately this program aims to build a research culture in which the professional and ethical competencies involved in research and natural resource management are both extolled and practiced.

"We must ensure that Australia ... provides opportunities for our best and brightest researchers ... training for the researchers of tomorrow... Not only will they be the leaders in producing fundamental knowledge, they will also be instrumental in disseminating new knowledge to the community and provide training for the researchers of tomorrow." (1)

Some background

My professional background includes high school geography teaching in East Gippsland, adult and community education throughout Queensland and lecturing at Griffith University. I hold a Masters Degree in adult and community education and have been involved in coordinating professional development programs for several years. In developing educational activities with the CRC, I will work closely with the CRC's Education and Training Program Leader John Fien.

I hope to contribute to those education and training opportunities which support students' research projects, as well as providing opportunities for participation in related CRC projects and industry placements. Field placements or internships are an excellent strategy for students to gain an appreciation of issues in the CRC's Focus Catchments and of the interests and needs of agencies involved in catchment management.

Developing participants' expertise

Workshops, short courses, structured Internet discussion, seminars and conference participation, study tours and industry placements are also within the scope of the program. Through a range of activities, the CRC hopes to develop participants' expertise not only in research skills and field activities, but also in key areas such as science communication, the science-policy interface, science and environmental management and public participation. These studies will complement the traditional research training provided in a postgraduate degree.

The program will initially target the CRC's PhD students, before broadening to encompass training needs of other postgraduate students and researchers, agency and public stakeholders and community members including university and school students. A survey of professional development aspirations is underway to help identify PhD's priority training areas. I also hope to correspond or meet with Program Leaders and CRC Parties in coming months to identify shared goals and priorities.

Possible accreditation for training

It is intended that accreditation for the professional development activities coordinated through this program will ultimately be available. The CRC's Education and Training team are engaged in discussions concerning the creation of a graduate certificate, tentatively called "Science Leadership", to be made available through the CRC. This graduate certificate would recognise appropriately selected and documented professional development, providing an organising framework. With this in mind, we are considering how best to develop portfolios combining both core and optional content and arrangements for reporting and reflecting on activities undertaken.

Your involvement welcomed

Your active involvement will ensure activities effectively address opportunities and challenges as they arise.

CRC researchers and industry participants in particular are encouraged to consider how they may benefit from and contribute to the program. Are there opportunities within your programs for postgraduate student placement? Can you help identify opportunities for training and other professional development? Are you currently promoting in-house training activities to other CRC researchers and students? Are your staff willing to lead workshops to help create a new generation of researchers abreast of contemporary innovations and the adoption environment within which you operate?

I am very eager to hear from *Catchword* readers. If you have ideas or suggestions or seek further information, please contact me.

Reference

(1)Knowledge and Innovation: a policy statement on research and research training December 1999, Hon D.A.Kemp MP Minister for Education, Training and Youth Affairs p.iii

James Whelan
Tel: 07 3875 7457
Fax: 07 3875 7459
Email: James.Whelan@mailbox.gu.edu.au

POSTGRADUATES AND THEIR PROJECTS

Our postgraduate for October is:

Myriam Ghali

My interest in our environment started "officially" in 1990 when I joined the University of Trier in Germany. As a physical geography/geosciences student I learned to appreciate the diversity of the environment and its complex processes. In addition to the years of solid education (we Germans love to study until we are old and grey) I have acquired an appreciation for travelling, especially to Australia. After completing my masters in 1998 I worked with Munich Re, but once again I wished to travel to this awesome country, Down-Under.

I arrived in Australia in July 1999 for the third time and started my PhD shortly after. Since then I have been learning something new every day about this unique country and about my PhD subject too!

My thesis is entitled: Setting priorities for stream rehabilitation: evaluation of existing methods. This project is being carried out under CRC Program 6: "River restoration". I am based at the University of Melbourne and am now 10 months into my project.

Background to project

Australia has tens of thousands of kilometres of streams that have been degraded by humans. Many tens of millions of dollars are now being devoted to rehabilitating streams, but a fundamental question is: where should managers start rehabilitating them? How should they set priorities?

This research project aims to identify and understand the main impediments to the successful application of procedures for setting priorities, and to provide recommendations to improve those procedures.

The project structure

The research methodology for this project has been divided into four major elements:

Theoretical approach

Identification of various theoretical priority setting methods in the fields of Health Care, Conservation, Wetland Management and River Restoration. Three sets of questions are addressed in this section to identify the basis of any priority setting.

- On what value systems are decisions on priorities based?
- Are values measurable and what methods can be used to measure them?
- How are priorities set in other fields?

Issues examined in this section include the definition of values, and their impact on priority setting procedures in the public sector, environmental areas and river rehabilitation projects.

Legal and political imperatives of priority setting

A key question is:
What are the processes, mechanisms and considerations involved in setting "river restoration" priorities at federal, state and community levels, and how do they interact?

As part of the legal and political study, the Australian Constitution Act will be used to analyse the distribution of powers between the Commonwealth Government and the Victorian State Government, regarding river restoration issues. The impact of international guidelines on priority setting by the federal and state governments will also be investigated.

At state level (e.g. Department of Natural Resources and Environment), policies and legislation concerning decision procedures in environmental projects will be examined. A typical practice in setting priorities in river restoration projects at the state level will be analysed. The factors which determine the state river restoration priorities will also be studied. An important issue that will be discussed is the degree of interaction between researchers and authorised boards in establishing and assessing priority setting factors.

A further consideration will be the extent to which a Catchment Management Authority (CMA) has to follow any state government guidelines on priority setting.

Environmental priorities are also set at non-governmental levels. The manner in which non-governmental organisations (NGO's) spend their budget indicates indirectly their goals and the way the organisation sets its priorities. These indirect methods of setting priorities will be explored.

The catchment level

Pilot and case studies on specific sites will be closely investigated. These sites will be selected because of already performed or ongoing restoration projects, e.g. NE CMA. The following questions will be addressed in the pilot and case studies.

- What are the overall considerations in choosing a method for setting priorities?
- Who is setting the priorities?
- How strong is the community impact on the priority setting phase?
- On what baseline data are the priorities set?

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If you want information about catchment hydrology, start with our website.

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- How are priority setting methods applied in situ?

Conclusions and recommendations

The key principles of priority setting procedures for River Rehabilitation, Conservation, Wetland Management and Health Care will be presented.

Further, the legal and political impediments inherent in the political structure will be highlighted. The results of the evaluation process of currently applied priority setting procedures will be presented.

Finally, recommendations will be provided based on this study to enhance the outcomes of stream rehabilitation projects through improved approaches for priority setting.

Comments requested

As any research project gets better through feedback, I would much appreciate any comments you may have.

Myriam Ghali
Tel: (03) 8344 7178
Email: m.ghali@civag.unimelb.edu.au

CRC PROFILE

Report by Heather Hunter

Way back when I decided on a career in biochemistry, some people considered that biochemists were about as employable as elephant trainers. Nevertheless I persisted and since then have found myself in a number of interesting and diverse fields. Over this time (and oblivious of the problems of 'up-scaling'), I've moved from a focus on sub-cellular processes to those that operate in river catchments. These days I sometimes call myself a biogeochemist.

I became involved in agriculture and natural resource management after marrying an agricultural scientist. Soon after graduation from the University of Queensland, Mal and I spent six years in Papua New Guinea, based at the Bubia Experiment Station outside Lae. It was a fascinating time to be there, towards the end of the colonial era in the late 1960s to early '70s. The old-timers (on reflection, they probably weren't really old at all!) could still recount their World War II exploits and point out the landmarks of historic battles, while at the same time the country was emerging towards independence. Sadly, from most accounts PNG isn't such a pleasant place to live in to-day.

Soon after arriving in PNG I was employed by the Department of Agriculture, Stock and Fisheries to work on a project sponsored by the International Biological Programme. The overall goal was to provide villagers living in remote areas with a means of producing protein concentrates to supplement their diet. The concept was simply to harvest young leaves and shoots, macerate them to extract the juice, and then scoop off the coagulated protein after heating the juice to around 80°C. My job was to evaluate the protein content of a wide range of vegetation using this procedure in the lab and to test selected species in a village-scale production unit. One of the promising species we worked on was elephant grass, which is as close as I've been to working with elephants. The trials all worked quite well, but the villagers subsequently showed little interest in consuming the product! Hopefully we have learnt a few things about stakeholder participation since those days.

Then followed a number of years spent at home with our two young sons, with some post-graduate study in plant biochemistry in the mid-1970s. My understanding of soils and landscapes really began in the early 1980s with my appointment to the Department of Primary

Industries at the Biloela Research Station in central Queensland. I was fortunate to take part in two long-term multi-disciplinary studies in the semi-arid sub-tropics, one investigating the effects of conservation cropping practices on soil fertility (amongst other things), and the other, the Brigalow Catchment Study, assessing the effects of land clearing and land management practices on catchment hydrology, soil properties and productivity. Thus emerged my interests in nutrient cycling processes in soils and nutrient transport in catchments. My particular hobbies (and PhD research) at that time included measuring soil microbial biomass and denitrification under different soil management systems. Recollections from those days include the dedication of our project teams, the camaraderie of life at the research station, and the frustration of waiting for runoff events to occur at Brigalow!

My research interests in the 1990s moved more towards aquatic systems and the effects of land use on downstream water quality. Once again I became involved in a catchment runoff study, although this time on a very much larger scale and in the wet tropics, with rainfall (generally) in abundance. The Johnstone River project was a large, multi-disciplinary study conducted over six years. Thanks to the contributions from many colleagues, we were able to quantify the long-term average loads of nutrients and sediment exported from the catchment to the Great Barrier Reef lagoon, and to identify the source areas and land uses within the catchment associated with those loads. Based in Brisbane since 1990 (and now with the Department of Natural Resources), my other research activities have included evaluating contaminant removal from irrigation drainage by constructed wetlands in the Burdekin, exploring eutrophication processes in small freshwater streams in south-east Queensland, and measuring nutrient exports from sugar cane farming areas in Mauritius and Australia.

So to my present involvement with the CRC, where I have welcomed the opportunity to develop, with others, a project on nitrogen and carbon dynamics in riparian buffer zones (project 2.5). We will also be examining these processes in coastal riparian wetlands, in a companion project with the Coastal CRC. In many ways it seems like a natural progression for me, linking my experience in soils and river systems and probing the connections between the two. Our project is now rolling, we have our post-doctoral research fellow, Christie Fellows on board, so watch this space!!

Heather Hunter
Tel: (07) 3896 9637
Email: Heather.Hunter@dnr.qld.gov.au

WHERE ARE THEY NOW?

Report by Phil Scanlon

My PhD study was part of the CRC's Urban Stormwater Program, and I completed my PhD titled "Effects of Mixing on the Transport of Pollutants within Ponds during Storm Events" just in time to have a year date starting with a 1 rather than a 2. After a holiday, I worked as a casual research assistant with Murray Peel and Francis Chiew at the University of Melbourne on the National Land and Water Resources Audit, while waiting for the project I am currently working on to begin.

I am now working as a Research Fellow on the CRC Associated/Additional project "Modelling and Estimating Sediment and Nutrient Loads in South East Queensland Catchments" with Francis Chiew. This project has developed as part of the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS), a study that expanded from the estuarine and coastal focus of the Morton Bay Study to include the freshwater rivers and their catchments. Results from this project will be incorporated into another SEQRWQMS project, "Development of an Environment Management Support System (EMSS) for catchments in South East Queensland", which also is a CRC Associated/Additional project.

Phase 1 of the project is to identify, collect and analyse data that has been gathered in South East Queensland catchments that can be used to develop a rainfall-runoff-pollutant load model. I am currently liaising with state government departments, local government and other agencies to obtain time-series precipitation, stream flow, and water quality data, as well as spatial data describing the catchments such as land use and soil types. Phase 1 will conclude with a report detailing recommendations on the complexity of model that can be supported by the available data, and identifying opportunities for further monitoring to gain a more complete picture of water quality within the catchments.

In Phase 2 of the project a sediment and nutrient load model will be developed in line with the recommendations of Phase 1 and the approval of the SEQRWQMS, to sit within the EMSS framework developed by the CRC in the other SEQRWQMS project. The model will be calibrated and validated using the available data, but will also be designed to incorporate further complexity easily if additional data becomes available.

After quite a few years studying the hydrodynamic aspects of water quality in a small pond and collecting my own data, this work is a great opportunity to experience a short project, looking at the hydrologic aspects of water quality, in large catchments, using data collected by others.

Phil Scanlon
Tel: (03) 8344 5627
Email: p.scanlon@civag.unimelb.edu.au

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The CRC event calender at www.catchment.crc.org.au allows you a 'sneak preview' of what is coming up month by month.

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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

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