NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 81 MARCH 2000

A NOTE FROM THE DIRECTOR

Professor
Russell Mein

Inside...

Research program underway

At its February Meeting, the Governing Board approved funding for an initial 11 (of the expected 14) core projects of the CRC. A further three projects require working up in conjunction with the CRCs for Freshwater Ecology and/or Coastal Zone; approvals for these projects will be sought from the Board in May.

It has been decided that each CRC core project will be funded for three years initially, although most envisage a longer period to meet the targets set in the CRC Business Plan. The aim is to conduct a full review of each project, and to re-focus (or discontinue) as appropriate to best achieve the desired outcomes. At this time (ie three years hence), we would expect to start several new core projects.

Research program overview

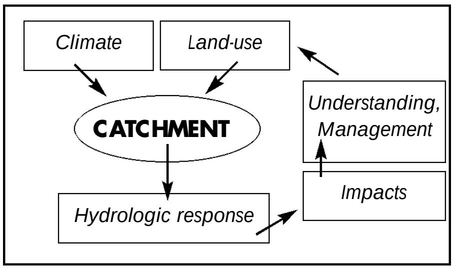
The CRCs research program is both an exciting and challenging one. The high degree of integration between individual projects with others to achieve the target of catchment scale hydrologic prediction is a particular feature of the project 'set'. This integration extends to the Programs for Communication and Adoption, and Education and Training; they are just as important as the research programs in the overall goals of the CRC.

Details of individual projects have appeared in recent editions of *Catchword*, under the relevant Program Headings. I propose to use this column to provide an broader overview, to show how each program contributes to the main goal - predictive capability for water, sediment, solute, and nutrient movement at catchment scale.

Overview Part One - Climate Variability

Key to catchment response

Figure 1 depicts the main objective of the CRC – predicting catchment behaviour. It shows climate as the 'driver' of catchment response, with land-use (or land cover) as an important factor in this. The figure also indicates the potential for better management of land-use (eg for sustainability) if predictive tools are available to evaluate the impacts of different management strategies.



Need for detailed input data

In the consideration of climatic inputs to catchments, average values (eg of rain) are somewhat meaningless. All of us are aware of the tremendous variability of climate in Australia, compared with most other countries), and the high incidence of flood and drought that results. The current situation of floods in Queensland and drought in Victoria are part of this pattern.

The relation of rainfall to runoff (yield) from a catchment is a nonlinear one. If rainfall is doubled, the resulting runoff is (nearly always) increased by much more than that. Hence, for this component of catchment prediction, modelling the variability of climatic inputs (rainfall, evaporative potential, temperature, etc) is essential to simulate changes in runoff.

The further aim of predicting sediment, solute, and nutrient movement will require more detailed specification of climatic variables. For instance, the generation of sediment (through erosion) is dependent on rainfall intensities at particular locations on a catchment. Hence rainfall needs to be described in both space and time, with far more precision than is possible using traditional raingauge networks.

Project targets

Thus, the Climate Variability Program aims to provide climatic inputs to our catchment models in the spatial and temporal detail needed for the processes being considered. Its two projects each target different aspects of this, namely climate forecasts and stochastic climate generation. The former will enable the advances being made in short, medium, and longer time forecasting of climate (by the Bureau of Meteorology) to be made more useful to land and water managers. The latter will provide simulated climatic sequences on a catchment, appropriately distributed in space and time, for use in modelling of scenarios of land management.

More detailed reports of our 'climate' projects will be given in the relevant Program reports in *Catchword*. Suffice to say that, for the CRCs objective of prediction at catchment scale, much depends on their success.

Russell Mein
Tel: (03) 9905 2704
Email: russell.mein@eng.monash.edu.au

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by Bryson Bates

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by Nanda Nandakumar, Russell Mein, Lionel Siriwardena

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WORKING DOCUMENTS

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97/1 Development and testing of a variable proportional loss model
by Lionel Siriwardena, Peter Hill, Russell Mein

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96/2 Comparison of two adoptive unit hydrograph: methods for real-time flood forecasting
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95/6 Estimation of extreme rainfalls for Victoria – application of Schaeffer's method
by Fiona McConachy

95/2 Development and testing of a variable proportional loss model based on 'saturation curves' (a study on eight Victorian catchments)
by Lionel Siriwardena and Russell Mein

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

Report by Assoc Prof Rodger Grayson

Project 1.2

This month's note is devoted to Project 1.2 - *Scaling procedures to support process-based modelling at large scales.*

Complexity and modelling

I am sure that any of us who have spent much time trying to measure, model or even just observe hydrological processes, have wondered long and hard about how much of that wonderful complexity that we see in nature, actually matters when it comes to our particular problem or modelling exercise. In Project 1.2, "the scaling project", we intend to develop some generic, parsimonious approaches to representing the effects of small-scale variability of soil and landscape characteristics on various hydrological responses, that can be used in large scale models. These approaches will be based on both a physical understanding of the processes, and actual data of measured variability. Now that the CRC Board has given the final nod, we are all set to launch into the grimy detail of turning these ideas into workable methods.

Project team for Project 1.2

The project team is based at Melbourne University, the Bureau of Meteorology and CSIRO Land and Water at Black Mountain. Andrew Western will be the key research fellow at the University of Melbourne. A new position will be advertised shortly for a research fellow who will work largely on Project 5.1 (Project Leader Francis Chiew) but will spend roughly 1 day per week with our project to help test our ideas in a "real world" modelling exercise.

Other related modelling

Project 5.1 involves the Bureau of Meteorology's Numerical Weather Prediction (NWP) model. This model is used to forecast conditions out a few days, at a spatial resolution of 12.5 x 12.5 km (with the intention of going to 5 x 5 km). The model currently has a simple approach to the representation of variability in soil moisture over a model element, but there is scope for improving this representation. Graham Mills and Alan Seed (both at the BoM) will be involved in the NWP testing.

We will also work closely with Project 2.3 (Project Leader Lu Zhang) on predicting catchment water yield and salinity under different vegetation and climate scenarios. While the modelling questions are quite different, the fundamental problems of dealing with small-scale variability in the context of large-scale models are very similar. John Gallant (CSIRO Land and Water) is part of our project team and will be focussing his work on areas of relevance to Lu's modelling approaches.

Postgraduates

To round out the project team, we hope to attract a couple of PhD students, although it seems that good applicants are pretty thin on the ground at the moment!

Tasks ahead

As far as the actual work goes, in the first year we have two key tasks – a thorough review, and some analysis of exiting data.

Variability at smaller scales

Andrew and I will be reviewing approaches taken around the world to deal with this general question of "sub-grid" (or sub-time step) variability – i.e. how to represent variability at a scale smaller than the elements (or time steps) used in models. This will be done in two parts. The first part will focus on the literature related to the effects of scale on processes, and the characteristics of spatial and temporal variability in process controls. The second part will focus on the modelling approaches that have been used or proposed for representing the sub-element and sub-time-step variability of these process controls.

Soil moisture data

We will also be analysing detailed soil moisture data sets covering a range of measurement methods (ground, airborne and satellite based) and a range of scales from 10s of ha to 1000s of km^2. Some of these data are from CRC for Catchment Hydrology Parties, while some are from international groups. Indeed we are very keen to hear from ANYONE, especially anyone involved in field sites around Australia, who has detailed soil moisture data that they would be willing for us to use. The intention of these analyses is to develop ways of characterising the variability in a form that can be used in model algorithms – initially with the Bureau of Meteorology's model, but later with the modelling being done as part of Project 2.3.

Rodger Grayson
Tel.: 0417 054 660
Email: rodger@civag.unimelb.edu.au

NEW INDUSTRY SEMINAR VIDEO

MANAGING SEDIMENT SOURCES AND MOVEMENT IN FORESTS: THE FOREST INDUSTRY AND WATER QUALITY.

Presented by

Dr Jacky Croke
CSIRO Land and Water

Dr Peter Wallbrink
CSIRO Land and Water

Mr Peter Fogarty
Soil and Land Conservation Consulting

CRC VIDEO 00/1

This video was recorded in Melbourne last year; the first of the three seminars held in Victoria and NSW during November.

It will be of interest to anyone involved in forest and catchment management.

NEW INDUSTRY REPORT

THE REUSE POTENTIAL OF URBAN STORMWATER AND WASTEWATER

by

Grace Mitchell
Russell Mein
Tom McMahon

Report No. 99/14

This report deals with the feasibility of reusing stormwater and wastewater to reduce the demand on the potable water supplies in Australian cities. It also describe 'Aquacycle' - a model developed by the CRC to assist in this process.

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PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Peter Hairsine

International collaboration on sediment deposition

Minimising sediment delivery

Many of the methods of minimising sediment delivery to our streams rely on depositing sediment after it has been eroded and before it reaches the stream. Contour banks, filter strips and sedimentation ponds are all widely used forms of such deposition-inducing measures. Deposition of sediment is also associated with the trapping of sediment-sorbed pollutants including nutrients and some pesticides. However, it is widely observed that trapping of these pollutants is less efficient (to a highly variable degree) than the trapping of the sediments. This effect is widely known to be a result of selective sediment deposition, also called sediment sorting.

Sediment deposition at large scale

The description of such deposition is a key linking step in moving from plot scale erosion research to an understanding of sediment movement to the stream edge.

Work by Laurent Beuselinck on sediment deposition

The CRC has been fortunate to have Dr Laurent Beuselinck from the Laboratory for Experimental Geomorphology, UC Leuven, Belgium as a visitor over the last two months. Laurent is a specialist in the area of sediment deposition. As part of his PhD program he conducted a most extensive laboratory study[1] of sediment deposition. Using a flume with two segments, the lower with a reduced slope, Laurent measured sediment outflow and its size composition for a wide range of overland flow rates, surface slopes and input sediment concentrations. This time-varying data was complemented by cores of the deposited sediment at the completion of the experimental runs. In short, this data provides the ideal laboratory test of our understanding of sediment delivery and the sediment sorting.

Calibration and evaluation of physically-based models

During his visit to Australia, Laurent has worked with myself and Graham Sander[2] to calibrate and evaluate physically-based models of sediment deposition. The result has been that a new model describing the complex interactions in areas of deposition has been found to accurately predict the sediment delivery and size-sorting found in the laboratory. This is an especially exciting development given the broad range of conditions found in the data.

Challenge ahead

The challenge now is to test this development in the field and to make the model compatible with other models describing the related environment. This work is a key part of CRC for Catchment Hydrology Project 2.2: *Managing pollutant delivery in dryland upland catchments.*

If you wish to follow up on this work please contact either Laurent at laurent.beuselinck@geo.kuleuven.ac.be or myself.

Footnotes

[1]Beuselinck, L., Govers, G., Steegen, A. & Quine, T.A., 1999. Sediment transport by overland flow over an area of net deposition. Hydrological Processes,13 (17) 2769-2782.

[2] Graham Sander until recently worked at Griffith. He is now located at the University of Loughborough in England.

Peter Hairsine
Tel.: (02) 6246 5924
Email: peter.hairsine@cbr.clw.csiro.au

PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader: JOHN TISDELL

Report by John Tisdell

Initial analysis of temporary water trading in the Goulburn Murray Water region

Water markets in focus catchments

In the first phase of CRC Project 3.2 *Enhancement of the water market reform process: A socio-economic analysis of guidelines and procedures for trading in mature water markets* we will analyse the structure conduct and performance of water markets in the focus catchments.

Activity in Goulburn-Murray

Temporary trade in water entitlements in the Goulburn-Murray region has been possible since the late 1980's and trade between water right and diversion licensees commenced in 1994. The catchments within the region are divided into 9 zones with trade to date being most active in the Greater Goulburn Zone (1A and B). Trade can occur through private agreement or through an exchange established by the Goulburn-Murray Water Authority. In 1998/1999 and up to January of the 1999/2000 season, some 14% and 30% of temporary trades respectively were conducted through the exchange. The price and quantity traded through the exchange provides some insight into the workings of the market. The analysis that follows is based on data from the exchange.

Recent trading volumes and prices in the Goulburn-Murray area

Since the beginning of the 1998/99 water year (August to May) up to February 2000, 54,000 ML of water has been temporarily traded through the exchange in the Greater Goulburn Zone at an average price of $66/ML. *Figures 1 and 2* show the quantities traded and pool prices for this zone through time.

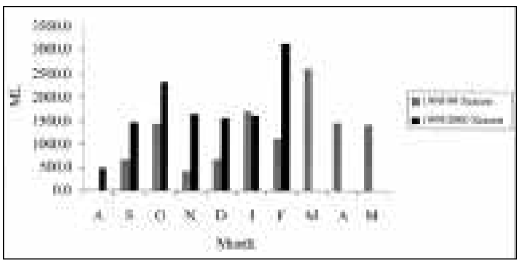

Fig.1: Volume Traded: Zone 1A and 1B - Greater Goulburn Zone

Figure 1 demonstrates a trend through the water year (August to May) with peaks in trade during critical watering periods and a decline in water trading towards the end of the season and during wetter periods in the region. As more data becomes available, it will be possible to decompose these trends and form forecasting models of trade and associated changes in water use. Initial analysis suggests that there has been a statistically significant increase in trade during the 1999/00 water year compared to the same trade periods last year. Graphically this difference can be seen in the corresponding volumes for *Fig 1* traded in the 1998/99 season and the 1999/00 season to date.

Market price variations

Figure 2 shows variations in price through time. The market price of water also exhibits seasonal trends with high prices at peak watering periods, declining towards the end of the season. For each period it is also possible to estimate the supply and demand curves from their respective schedules.

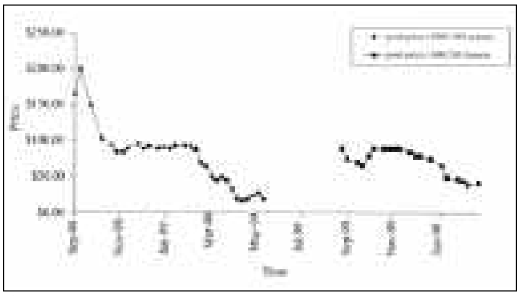

Fig.2: Pool Price in Zone 1A and 1B - Greater Goulburn Zone

Supply and demand for water

Figure 3 presents the supply and demand curves for trade on October 7, 1999. While the analysis is in its initial stages, the results suggest simple statistically significant models can be generated with over 90% explanatory power. The supply line is kinked at approximately $110/ML. This kink exists in other schedules also. It suggests that the market consists of two separate groups of suppliers, but this aspect requires further exploration. Finally, the functional forms of the supply and demand curves also requires further exploration and definition. Accurate definition of such functions will input into the understanding of trade and allow greater prediction of changes in water demand in the catchment.

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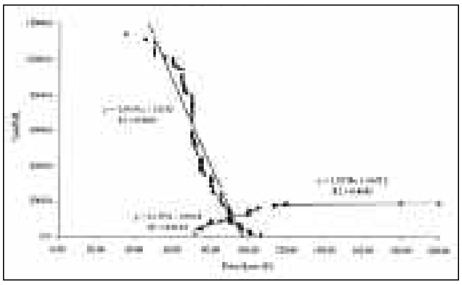

Fig.3: Supply and Demand - Zone 1a&b. 7 October 1999.

Optimisation in modelling water markets

To date, modelling water markets in Australia has involved using optimisation techniques because actual market data has not been available. As actual market data becomes more readily available, further exploration of the operating structure, conduct and performance of water markets will be possible. Equally important, it will be possible to evaluate the performance of optimisation models in predicting actual market behavior, and improve models of yet introduced water markets.

At a broader level, an understanding of how water markets operate in the focus catchments, and accurately modeling their behavior, are the first steps in determining the social and hydrological consequences of trade. Statistical analysis of data so far is encouraging and further exploration looks promising.

Footnote

I wish to thank the staff at Goulburn Murray Water for supplying the data necessary for this article.

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

PROGRAM 4
URBAN STORMWATER QUALITY

Program Leader
TONY WONG

Report by Tracey Walker and Britta Dahnke

Field experiments in a stormwater treatment wetland

Wetland Vegetation and the Removal of Suspended Sediments

While the use of wetlands is becoming widespread in urban design, there is little quantitative performance data to provide guidance in the design of these facilities to meet specific water quality targets associated with sediment-bound contaminants. Many stormwater pollutants, such as heavy metals, nutrients and polycyclic aromatic hydrocarbons are transported in particulate form. It is for this reason that the reduction of suspended solids in stormwater is considered a primary objective of stormwater treatment. Treatment processes promoted in constructed wetlands involve a combination of physical, chemical and biological mechanisms. The physical mechanism of enhanced sedimentation assisted by wetland vegetation is an important primary process. Factors influencing the effectiveness of enhanced sedimentation include a combination of sediment particle size, organic biofilm coating, and the types of vegetation within the wetland.

Past studies of sedimentation processes

Past research studies, notably by Sara Lloyd in 1997, have provided qualitative evidence of significant entrapment of fine particulates on surfaces of wetland vegetation. A detailed study into depositional patterns in the Monash University Research Wetland was undertaken to identify areas of high particulate removal. Overlay techniques were used to relate spatial patterns of sediment deposition to macrophyte distribution, basin bathymetry, and flow patterns. DAPI staining techniques were used to distinguish between algae and fine sediment attached to the macrophytes. This work provided documented evidence of the significance of particle adhesion to macrophytes as a mechanism of pollutant removal. High rates of clay removal resulted from the cumulative effect of flow retardation, biofilm growth over the surface of macrophytes, fine particle cluster formation and sediment adhesion. The trapping of fine particulates by sedimentation in non vegetated detention systems (eg. ponds) would not have been possible owing to their very slow settling velocities and high propensity to be kept in suspension by wind-induced flow turbulence.

Removal efficiency

According to standard sedimentation practice, the removal efficiency of suspended particles in sedimentation systems may be expressed as follows:-

$$R = 1 - \left(1 + \frac{1}{n}\frac{v_s}{Q/A}\right)^{-n}$$

where R = fraction of initial solids removed

v_s = settling velocity of particles

Q/A = rate of applied flow divided by the surface area of the basin or wetland

n = turbulence or short-circuiting parameter (between 0 and 1).

It is postulated that the presence of vegetation increases the fraction of solids removal, and that it is possible to quantify this effect by defining a "vegetation" function applied to either the dependent variable R (as above) or the particle settling velocity v_s.

Collaborative scoping study

Currently the CRC for Catchment Hydrology is conducting a scoping study to quantify the effect of vegetation on sediment removal in wetland systems. This study is in collaboration with the University of Essen in Germany. Britta Dahnke, an undergraduate student from the University of Essen, is presently working with the CRC in Australia on this project as part of her final year thesis. Britta has been analysing and interpreting the collected data.

Experimental set-up

The scoping study involves trialing experimental techniques for quantifying the significance of wetland vegetation in removing fine suspended solids in stormwater. Field site preparation and experiments have been undertaken at the Hallam Valley stormwater treatment wetland during the past month. The field preparation involved the establishment of two experimental channels some 3 m wide, 20 m long and 250 mm deep (*Figure 1*). One channel is densely vegetated. The other channel, which serves as a control channel, is predominantly open water with no vegetation. The channels were separated by plastic tubes filled with water.

Experimental flow regimes

Figure 2 Dosing Sediment Tracer into the Control Channel

Two different flow regimes including 1500 m/yr and 750 m/yr hydraulic loadings were used to test the effects of vegetation for sediment removal in the experimental channels. Flow into the channels is pumped via a constant-head tank. Steady flow conditions were first established before inputs of suspended solids of known particle size distribution (PSD) were carried out.

Figure 1 Two channels established for the field experiments at the Hallam Wetland (near Melbourne).

Tracer injection

The injection of graded sediment tracers (*Figure 2*) occurred over a ten minute dosing period at a suspended solids concentration of 6000 mg/L. Two sets of tracer PSD characteristics, described as clay dominant and sand dominant sediment mixes, were used in the experiments. Sodium Bromide was used as the conservative tracer in the experiments.

Water was sampled at regular intervals along the length of the channels to track the change in

NEW TECHNICAL REPORT

EFFECTIVENESS OF STREET SWEEPING FOR STORMWATER POLLUTION CONTROL

by

Tracey Walker

Tony Wong

Report 99/8

This report investigates the effectiveness of street sweeping as a stormwater pollution source control measure. It describes a scoping study to assess the efficiency of Australian street sweeping practices in the removal of pollutants from street surfaces.

Copies of this report are available from the Centre Office for $25.

NEW TECHNICAL REPORT

BLACKBURN LAKE DISCHARGE AND WATER QUALITY MONITORING PROGRAM: DATA SUMMARY AND INTERPRETATION

by

Sharyn RossRakesh
Chris Gippel
Francis Chiew
Peter Breen

Report 99/13

The 100 page report documents work undertaken by the CRC for Catchment Hydrology and the CRC for Freshwater Ecology on the performance of an urban pollution control pond in Melbourne.

Copies of this report are available from the Centre Office for $25.

concentrations of suspended solids, the particle size distribution, and water turbidity, as flow passed from the inlet to the outlet of the vegetated channel. The control channel provided the basis for quantifying the effect of wetland vegetation on improving the suspended solids removal efficiency where the removal of suspended solids was principally by sedimentation.

Why conduct a field based scoping study

Field experiments can often be difficult and unrewarding due to many unforeseen circumstances encountered in the field. It was therefore necessary to develop experimental techniques at a pilot scale before embarking on a full scale experimental program (scheduled for next summer).

Lessons so far

Some of the key experiences gained from this scoping study were:

- the establishment of the experimental sites took longer than first envisaged owing to the requirement to prevent leaks in the system. Leaks were detected using a dye tracer;

- the design of monitoring/sampling procedures required careful consideration and field trialing to enable adequate coverage of the tracer movement in the wetland. Sampling frequency and spatial coverage needed to be planned carefully to ensure cost-effective laboratory analysis. A number of sampling methods were trialed with contamination of samples due to re-suspension of settled particles being a major concern. This issue has not been fully resolved.

- in sampling, it was evident that the use of a dye tracer and continuous turbidity monitoring along the length of the channels can provide guidance on the movement of the sediment tracer through the channels.

- turbidity monitoring provided a real-time quantitative assessment of the performance of the channels in the removal of suspended solids. This is a very cost-effective means of monitoring, and opportunities for using turbidity as a surrogate measure for TSS under such experimental conditions are being examined further.

- it was evident from the experimental runs that there was significant mixing in the control channel (ie. open water) attributed to wind-induced turbulence. Flow conditions in the open water channel did not reach anywhere near plug-flow conditions. In the vegetated channel however, flow conditions were near to plug flow. There was clear evidence of short-circuit (or preferential) flow paths and zones of water re-circulation in the open water channel. These paths or zones were largely absent in the vegetated channel. As a result, the detention time provided in the open channel was in all cases significantly less than that in the vegetated channel.

Implications for vegetation aspects

The results of the current field study and future work will provide a basis for quantifying the enhanced particle removal processes attributed to wetland vegetation, possibly in the form of a "vegetation function" applied to conventional sedimentation theory. The results will also provide guidance for the botanical design of stormwater wetlands in terms of the appropriate species selection and layout to optimise pollutant removal efficiencies.

Tracey Walker and Britta Danke
Tel.: (03) 9905 5332
Email: tracey.walker@eng.monash.edu.au

PROGRAM 5

CLIMATE VARIABILITY

Program Leader

TOM MCMAHON

Report by Francis Chiew and Tom McMahon

At its meeting on 25 February 2000, the CRC for Catchment Hydrology Board gave final approval for the Climate Variability Program to proceed. The Program consists of two projects – 5.1: *Modelling and forecasting hydroclimate variables in space and time*, and 5.2: *National data bank of stochastic climate and streamflow models*. Both projects are funded for three years from January 2000 to December 2002.

Project 5.1 – Research areas

There are five research areas in Project 5.1. The first is on modelling space and time characteristics of rainfall, and forecasting spatial rainfall for the very short term (several hours ahead). Alan Seed from the Bureau of Meteorology is the primary researcher here.

The second research area is the testing and improving of surface hydrology in numerical weather prediction models, and involves field monitoring in the Murrumbidgee focus catchment. This research has very close links to Rodger Grayson's scaling project (see notes on Project 1.2 in this *Catchword*). A Research Fellow will be employed shortly to work on this project with Graham Mills and Beth Ebert in the Bureau of Meteorology Research Centre, and Andrew Western and Francis Chiew in the University of Melbourne. Background to these two research areas was presented in the September and October *Catchwords*.

The third research area will develop methods for downscaling atmospheric variables to local catchment variables. The methods will be tested on the Murrumbidgee focus catchment. Bryson Bates' group in CSIRO Land and Water will undertake research in this area.

The fourth research area concerns statistical models for forecasting seasonal streamflow. Research in this area will build on Francis Chiew's work as well as explore new promising methods.

Research in these four areas is underway.

The fifth research area will attempt to assess the use of seasonal streamflow forecasts in water resources management, and will build on the preliminary studies completed by Francis Chiew. Research in this area will be opportunistic and will depend on developments in other CRC projects and participation by the water agencies.

Project 5.2 - Aim

The aim of Project 5.2 is to develop algorithms to generate stochastically sets of daily rainfalls and concurrent climate data for any location in Australia. The methods will also be extended to provide the spatial distribution of monthly rainfall and climatic variables for large catchments. It will be tested initially for the Murrumbidgee focus catchment.

The project will operate largely from the Bureau of Meteorology and the University of Melbourne. Sri Srikanthan and Tom McMahon will work closely on the project and early next year a Research Fellow will be employed to support them. Research work on Project 5.2 has started, and a general literature review on stochastic data generation techniques is underway. A workshop for stakeholders will be held in late March to confirm the climate variables to be modelled.

Next steps

To round up the project team, we will be advertising for two Research Fellow positions and hope to attract a couple of PhD students. As you can see, there are several research areas in the Climate Variability program and they will each be discussed in detail in the coming *Catchwords*.

Francis Chiew

Tel.: (03) 8344 6644

Email: f.chiew@civag.unimelb.edu.au

NEW TECHNICAL REPORT

PREDICTING THE EFFECT OF VEGETATION CHANGES ON CATCHMENT AVERAGE WATER BALANCE

by

Lu Zhang
Warwick Dawes
Glen Walker

Report 99/12

This project's aim was to estimate the effects of afforestation or deforestation on run-off that leads to recharge to some of the alluvial catchments in the upland areas of the Murray-Darling Basin. The method proved to be very successful and can be more widely used by providing a basis for making estimates of the water yield impacts of wide-scale afforestation in Murray-Darling Basin

Copies of this report are available from the Centre Office for $25.

TECHNICAL REPORT

GUIDELINES FOR STABILISING STREAMBANKS WITH RIPARIAN VEGETATION

by
Bruce Abernethy and Ian Rutherfurd

Report 99/10

The Queensland Department of Natural Resources contracted the CRC for Catchment Hydrology to write technical guidelines to help specify the width and composition of vegetated riparian zones, for bank erosion control.

This report will guide and focus the practitioner's approach to planning riverbank stability works using vegetation.

The report is available from the Centre Office for $25.

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

PROGRAM 6
RIVER RESTORATION

Program Leader
IAN RUTHERFURD

Report by Ian Rutherfurd

Update on the River Restoration Program

Some astute people who read their CRC for Catchment Hydrology Board meeting minutes will have noticed that the Restoration Program was not included in the projects given the go-ahead by the February Board Meeting. So to remind people who may have missed earlier *Catchwords*, the River Restoration program is not being ratified by the Board until it has been able to develop joint project agreements with the Cooperative Research Centre for Freshwater Ecology. This will not be possible until May or June of this year.

Major funding for evaluation

In another joint initiative with the Cooperative Research Centre for Freshwater Ecology, the River Restoration Program (through The University of Melbourne) has won a grant from the Murray-Darling Basin Commission (MDBC). This $50,000 grant is to select a site, and develop a proposed methodology for testing the effectiveness of stream habitat restoration works undertaken in the Murray-Darling Basin. The grant-supported work and proposals are a prelude to a possible second stage of the project which will actually evaluate a stream restoration project over several years. In essence, this project will apply a rigorous evaluation procedure to a project which may be planned by a third party for a river in the Murray-Darling Basin.

Target issues for project

Why is this an important project? Many stream rehabilitation projects in Australia aim to increase the abundance and diversity of organisms living in the stream by improving the availability of habitat. Habitat could be improved, for example, by physical changes such as more large woody debris, pool depth, or bed material. Despite the large investment in this area, there have been almost no rigorous studies of the effectiveness of such habitat restoration. There are good reasons why this is so. The experiments are often difficult to design, and can require many years to get a conclusive result. They require long-term cooperation between physical and biological scientists, and with the management agencies carrying-out the work. The evaluation can also cost considerably more than the physical cost of the works.

The MDBC are committed to improving stream health, and believe that the two CRCs have the expertise to design and evaluate a major habitat experiment. Also, we will be around for long enough to do the work, (ie. more than five years).

Project stages

The project has five stages as follows - all being guided by an expert panel.

- Review existing habitat evaluation projects world-wide, and identify possible experimental designs and approaches
- Develop criteria for selecting projects as experiments (that is, there are many dozens of habitat improvement projects underway in Australia, but only a few of them would fulfil all of the criteria for a habitat experiment)
- Decide on the type of habitat experiment (eg. Target species, types of treatment)
- The physical construction of the project will be carried-out by a partner organisation, so we will identify potential collaborating partners and projects. These could come, for example, from the Natural Heritage Trust.
- Select a site and design the project.

Further ideas

If any reader has ideas for this project, or particularly, ideas about sites and projects that this project could collaborate with, please contact Ian Rutherfurd (i.rutherfurd@geography.unimelb.edu.au), Mike Stewardson (m.stewardson@civag.unimelb.edu.au), or Peter Cottingham of the Cooperative Research Centre for Freshwater Ecology (Peter_Cottingham@enterprise.canberra.edu.au).

The scoping project will be completed by mid-2000.

Ian Rutherfurd
Tel.: (03) 8344 7123
Email: i.rutherfurd@geography.unimelb.edu.au

COMMUNICATION AND ADOPTION PROGRAM

Program Leader DAVID PERRY

Report by Pat Feehan

Introducing the Goulburn Broken Catchment

Main rivers

The Goulburn Broken catchment is in central northern Victoria and comprises the catchments of the Goulburn and Broken Rivers and a small part of the Murray Valley, upstream of Echuca. The catchment covers a total of 2 391 544 ha, or 10.5% of Victoria's total land area. Some 250 000 people live in the catchment.

Climate/hydrology

A number of the Goulburn's major tributaries rise on the northern slopes of the Great Dividing Range. Rainfall varies substantially. The high country in the south east experiences cool winters with persistent snow and an average annual rainfall greater than 1600 mm. Rainfall decreases northward and in the far north of the catchment is less than 450 mm per year, only one third of the annual evaporation in that area.

The Goulburn catchment produces on average 1.8 ML/ha/yr while the drier Broken catchment produces 0.42 ML/ha/yr.

Terrain varies from the high ranges with an altitude greater than 1200m, to the Murray Plain with an altitude of around 100m. The northern half of the catchment is relatively flat.

Vegetation

The catchment was once forested over its entire area. While native vegetation has been retained in the mountainous far south, where slopes are steepest, clearing for agriculture has been extensive in its valleys and plains. Approximately 50% of the catchment is used for dryland agriculture (cropping and grazing), about 30% is forested and the balance is irrigated.

Dams and rivers

Two major features, Lake Eildon and Goulburn Weir, have modified streamflow along the Goulburn River. Lake Eildon has a capacity of 3 390 000 ML and supplies more than half of the water used in the Shepparton Irrigation Region. The Goulburn Weir near Nagambie diverts water east and west to irrigated areas. This has substantially altered stream flows in the Goulburn River.

Industry

Extensive food processing industries in the region produce some 25 percent of Victoria's rural economic output. The network of industries is recognised as one of the nation's "food bowl" centres and these industries collectively have invested hundreds of millions of dollars in the introduction of world class technology and international best practice to their operations to maximise their export opportunities.

The continued well being of the region relies on supply of good quality water to primary producers and food processing industry.

Irrigation

Irrigation areas to the west also rely on water supplied from the Goulburn Broken catchment. Infrastructure investment by Goulburn-Murray Water (G-MW) alone totals $2.6 billion. G-MW delivers rural water services to customers on 24 000 serviced properties across northern Victoria.

Catchment scale water issues

Water Quantity

- Catchment yield – there is concern about the potential impacts on water yield of large scale afforestation programs and irrigation development away from traditional irrigation areas. The potential impacts of climate change are another concern.
- Water supply system performance management. The reliability and predictability associated with managing the water supply channel system is of great importance to water supply authorities and their customers.
- Improvement in the water delivery system, especially minimisation of losses and measurement improvements are key issues.
- Water trading now allows water to move between areas. Understanding the impacts of trade on the supply and delivery system and ensuring the water market is maximising the economic benefits of water use and minimising disbenefits is very important.
- New developments and enterprises – new developments away from traditional irrigation areas can impact on downstream users and the environment.

Water Quality

Salt

Forty-five percent of the Shepparton Irrigation Region is currently underlain by shallow watertables and this will rise to 60% if nothing is done. In this scenario, annual losses are expected to rise from the current $30 M to $47M by 2000 and $90M by 2020.

To address these issues, the Shepparton Irrigation Region Land and Water Salinity Management Plan has been

UPCOMING CANBERRA SEMINAR

AN OVERVIEW OF THE NEW AGROFORESTRY DESIGN GUIDELINES BOOK

Speaker

Dr Richard Stirzaker
CSIRO Land and Water

WEDNESDAY 19 APRIL 2000

at the Conference Room
C.S. Christian Laboratory
CSIRO Land and Water
Black Mountain Laboratory
Canberra,
Clunies Ross Street, Acton.

Time
10.45am for 11.00am start

Tea/Coffee on arrival

See the flyer with this *Catchword* for details.

NEW WORKING DOCUMENT

**DEVELOPMENT OF A REAL-TIME FLOOD FORECASTING MODEL
VOLUME 4: EVALUATION OF THE XINANJIANG-URBS MODEL**

by
R. Srikanthan
M.H. Khan
P. Sooriyakumaran
J.F. Elliott

Working Document 00/1

This working document and the three others in this series are available from the Centre Office for $20 each.

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

endorsed by Government. This 30 year plan is in the tenth year of implementation..

In the dryland region some 4500 ha is heavily salinised. This will ultimately increase to 38 000 ha. in 50 years if nothing is done.

The catchment exports an average of 180 000 tonne of salt from dryland catchments to either the River Murray or the irrigation region. This is expected to increase to 250 000 tonne in 50 years if nothing is done.

Nutrients

Blue green algal blooms occur frequently in and downstream of the catchment. The Goulburn Broken was nominated as Victoria's highest priority for nutrient reduction in the Murray-Darling Basin Commission's Algal Management Strategy. An average of 360 tonne of phosphorus is exported from the catchment annually. Major nutrient sources include irrigation drainage, dryland and sewage treatment plants. The Goulburn Broken Water Quality Strategy aims to reduce catchment nutrient loads by 65% over 20 years.

River Restoration

Some 45% of the catchment's waterways are estimated to be in very poor, poor or moderate environmental condition. The Regional Catchment Strategy aims to improve the condition of 3000 km of stream to good or excellent condition over 30 years while maintaining the environmental condition of streams currently rated good or excellent.

Fishways have been constructed on weirs at a number of sites along the Broken River and Broken Creek.

Water quality in streams in the catchment progressively deteriorates downstream. (for summary information about water quantity and quality in the catchment see (http://www.nre.vic.gov.au/catchment/water/vwrmn/vic/index.htm)

Water allocation

The Bulk Entitlement (BE) Program for the Goulburn and Murray Rivers has been completed. Bulk entitlements specify a finite share of the water resource for a water user at a primary source of harvesting or from the point of extraction. BEs enable the establishment of the water trading framework at two levels: at the bulk level between authorities by trading bulk entitlements, and in rural areas at the retail level by individual irrigators trading temporary and permanent water entitlements.

The MDBC Cap has placed further constraints on the level of diversion from the stream system.

Environmental flows in regulated streams have been specified. In unregulated streams, Stream flow Management Plans are being developed to address water diversion and environmental flow issues.

Groundwater

Many of the catchment's groundwater systems are heavily committed, or even overcommitted. Development of groundwater management plans for key systems is underway.

Catchment management arrangements

The Goulburn-Broken Catchment Management Authority leads an integrated approach to the protection and enhancement of the catchment's land and water resources. Working with its catchment partners, including Goulburn-Murray Water, Goulburn Valley Water, and the Department of Natural Resources and Environment, the CMA is implementing its Regional Catchment Strategy. Where necessary, detailed strategies to address key issues (eg salinity, water quality, native vegetation) have been, or are being, developed.

Pat Feehan
Focus Catchment Coordinator (Goulburn Broken)
tel: 0358 335 687
Email: pfeehan@g-mwater.com.au

CRC PROFILE

Carolyn Young

At the end of high school, deciding I'd rather save the world than paint the world, I ventured off to university to learn about the environment. Fours years later I emerged with a Bachelor of Natural Resources (Hons) from the University of New England.

Shortly after, I landed a job with the then NSW Department of Water Resources in Parramatta, and donned an 'Environmental Officer' hat. I worked with a terrific team implementing Nutrient Control Works across the State. Nutrient control works ranged from constructed wetlands for treating sewage, stormwater and dairy waste through to riparian buffer zones. I worked with sceptical bureaucrats (constructed wetlands were a bit newish then), and environmental champions who greatly expanded my technical skills.

After a year of working, whack!!, the travel bug hit me…and in 1995 I left for the green pastures of England and Wales. While there I worked with the National Rivers Authority (now called the Environment Agency) for six months. My challenge was firstly, to trial the NSW Total Catchment Management approach to natural resource management within a small catchment suffering blue-green algal blooms (familiar story!); and secondly, to investigate the causes of the blooms. Again I battled the sceptics "you're the government, why do you need us the community to help make decisions about the environment?" By the end of my project, those community members understood why and got involved. The Bittell Reservoirs Catchment Management Committee is still beavering away. They have completed their action plan and started implementation.

In late 1995 I returned to the wide brown land and the newly amalgamated NSW Department of Land and Water Conservation (DLWC) and took up the "Environmental Officer" hat again. Wanting an exit from Sydney (living in Glebe meant too many distractions and no money…), in late 1996 I headed off to Canberra and joined the Murray-Darling Basin Commission. Towards the end of my stay I knew the commands of the hydrological model BIGMOD (not a mean feat hey Andie?), and the ins and outs of several working groups.

Missing the State action, I (again!) returned to DLWC Nutrient Control Works Project in 1997, this time based in Queanbeyan. I took on the role as State Coordinator for the incentive scheme "Rivercare – Nutrient Control". We funded mostly river rehabilitation works and constructed wetlands amongst other oddities such as dung beetles. I also ventured into mine rehabilitation – researching the feasibility of treating mine waste with constructed wetlands at Captains Flat. Unfortunately for the Molonglo River bugs, the result was neither feasible nor suitable.

So where am I now? I'm the CRC for Catchment Hydrology Focus Catchment Coordinator (FCC) for the Murrumbidgee. Although I'm based in the Murrumbidgee, my position is State focussed – providing greater exposure for the CRC! We FCC's are the

- intelligence gatherers (eg report on current issues and identify opportunities)
- facilitators (eg help integrate related research)
- communicator (eg help communicate CRC research findings)
- mediator (eg provide a reality check to research activities).

As a Focus Catchment Coordinator, I aim to assist the CRC towards its main target – adoption of research outcomes.

When I'm not FCCing, I am working on CRC Project 2.1 Sediment movement water quality and physical habitat in large river systems and continuing with DLWC projects. I am part of the scientific, technical development and transfer division of DLWC - the Centre for Natural Resources. At DLWC I am applying Ian Rutherfurd *et al*'s "A Rehabilitation Manual for Australian Streams". I am also trialing the use of the manual to assist the NSW Water Reforms. Another DLWC project involves assisting with developing an intranet/internet site on landscape management.

So that's about all from me. I look forward to meeting more of you CRC for Catchment Hydrology people – and participating in the CRC's Sri Chimnoy triple triathlon team…

Carolyn Young
Tel.: (02) 6299 7688
Email: cyoung@dlwc.nsw.gov.au

NEW WORKING DOCUMENT

An Integrated Dataset of Climate, Geomorphological and Flood Characteristics for 104 Catchments in South-East Australia

The two volumes (750+pp) consist of over 150 papers covering all aspects of stream management.

by

Ataur Rahman
Russell Mein
Bryson Bates
Erwin Weinmann

Working Document 99/2

This document is available from the Centre Office for $20 each.

Please contact Virginia Verrelli on 03 9905 2704 to order your copy.

WHERE ARE THEY NOW?

Report by Richard Campbell

For the past three years I have been working for an environmental consulting firm, Environmental & Earth Sciences Pty Ltd. This company specialises in the areas of soil science and hydrogeology, and undertakes projects for a wide variety of clients in the industrial, agricultural and mining sectors.

Initially I was employed as senior hydrogeologist based in Sydney. The majority of the work has been soil science related, with projects ranging from assessment and remediation of contaminated sites (such as former gas works) to regional acid sulfate soil studies. Groundwater aspects have predominantly involved landfill studies and mining projects, with some groundwater resource studies as well.

For the last year and a half I have been based in Melbourne as Victorian Manager, being responsible for promoting the company and coordinating its operations. I am pleased to say the company is now well established with four employees on the books and a promising 2000 on the way. Apart from running around chasing work I have had some time to do some guest lecturing at The University of Melbourne, and performing my duties as Secretary of the Victorian Branch of the International Association of Hydrogeologists.

Unfortunately, since completing the Masters (Hydrogeology of a small forested catchment) utilising the model TOPOG, I have since not had the opportunity to apply TOPOG or forest hydrology in industry. However, recently I attended a conference in Townsville organised by the Australian Centre for Mining and Environmental Research. The focus of the workshop was Acid Mine Drainage, and amongst other things, techniques for encapsulation of sulfidic tailings and waste rock and methods for estimating the performance of this encapsulation.

So what has all this to do with forest hydrology? Well it turns out that a long term encapsulation program for sulfidic material has a similar hydrologic balance as a forested catchment. The modelling of moisture movement in the unsaturated and saturated zones in the sub surface, and estimation of evapotranspiration and soil storage parameters is vital to determine how much acid will be generated as the sulfides oxidise. The latest model being promoted is called "soil cover". It was developed in the University of Saskatchewan, and is very similar to TOPOG in that it estimates moisture fluxes in the unsaturated zone based on soil properties, and also estimates evapo-transpiration rates. It is however a one-dimensional model, and it relies on evapotranspiration data collected from fir trees in Canada.

During the conference it became clear that amongst others, the following areas are giving the mining industry some angst:

- Estimation of hydraulic parameters of tailings and waste rock
- Estimation of evapotranspiration rates of Australian Native species such as eucalypts and acacias
- Hydrologic modelling of saturated/unsaturated zone

It is also interesting to note that the initial CRC Project A1 was involved in the last two aspects. It would appear that some cross disciplinary communication may aid in research into acid mine drainage and save some research dollars.

My involvement with the CRC is limited to the odd email, but for any of the CRC mob who want to get in touch here are my details.

Richard Campbell
Tel: (03) 9646 8760
Email: eesi@ozemail.com.au

CRC CONTACT DETAILS

CRC PROGRAM LEADERS

Program 1: Predicting Catchment Behaviour

Program Leader - Dr Rob Vertessy
CRC for Catchment Hydrology
CSIRO Land and Water
GPO Box 1666
Canberra ACT 2601
Tel.: (02) 6246 5790
Fax: (02) 6246 5845
Email: rob.vertessy@cbr.clw.csiro.au

Program 2: Land-use Impacts on Rivers

Program Leader - Dr Peter Hairsine
CSIRO Land and Water
GPO Box 1666
Canberra ACT 2601
Tel.: (02) 6246 5924
Fax: (02) 6246 5845
Email: peter.hairsine@cbr.clw.csiro.au

Program 3: Sustainable Water Allocation

Program Leader - Dr John Tisdell
Faculty of Environmental Sciences
Griffith University
Nathan Qld 4111
Tel.: (07) 3875 5291
Fax: (07) 3875 6717
Email: j.tisdell@mailbox.gu.edu.au

Program 4: Urban Stormwater Quality

Program Leader - Assoc Professor Tony Wong
CRC for Catchment Hydrology
Department of Civil Engineering
Monash University
Clayton Vic 3800
Tel: (03) 990 52940
Fax.: (03) 990 54944
Email: tony.wong@eng.monash.edu.au

Program 5: Climate Variability

Program Leader - Professor Tom McMahon
CRC for Catchment Hydrology
Department of Civil & Environmental Engineering,
University of Melbourne
Parkville Vic 3010
Tel.: (03) 9344 6641
Fax: (03) 9344 6215
Email: t.mcmahon@civag.unimelb.edu.au

Program 6: River Restoration

Program Leader Dr Ian Rutherfurd
Department of Geography & Environmental Studies
University of Melbourne
Parkville Vic 3010
Tel: (03) 9344 7123
Fax.: (03) 9344 4972
Email: i.rutherfurd@geography.unimelb.edu.au

Program 7: Communication and Adoption

Program Leader - David Perry
CRC for Catchment Hydrology
Department of Civil Engineering
PO Box 60
Monash University, Vic 3800
Tel: (03) 9905 9600
Mobile: 0419 326 533
Fax: (03) 9905 5033
Email: david.perry@eng.monash.edu.au

Program 8: Education and Training

Acting Program Leader - Prof. Russell Mein
CRC for Catchment Hydrology
Department of Civil Engineering
PO Box 60
Monash University, Vic 3800
Tel: (03) 9905 2704
Fax: (03) 9905 5033
Email: russell.mein@eng.monash.edu.au

CRC FOCUS CATCHMENT COORDINATORS

Mr Chris Carroll

Dept Natural Resources
PO Box 736
Rockhampton Qld 4700
Tel: (07) 4938 4240
Fax: (07) 4938 4010
Email: chris.carroll@dnr.qld.gov.au
(Focus Catchment Coordinator Fitzroy River)

Mr Pat Feehan

Goulburn-Murray Water
PO Box 165
Tatura Vic 3616
Tel: (03) 5833 5687
Fax: (03) 5833 5509
Mobile: 0407 408 422
Email: pfeehan@g-mwater.com.au
(Focus Catchment Coordinator Goulburn-Broken River)

Mr Graham Rooney

Melbourne Water
630 Church Street
Richmond Vic 3121
Locked Bag 4280
East Richmond Vic 3121
Tel.: (03) 9235 2105
Fax: (03) 9429 7174
Email: graham.rooney@melbwater.com.au
(Focus Catchment Coordinator Yarra River)

Mr André Taylor

Urban Management Division
Brisbane City Council
GPO Box 1434
Brisbane Qld 4001
Tel.: (07) 3403 9402
Fax: (07) 3403 9456
Email: pwpoq@brisbane.qld.gov.au
(CRC Alternate Board Member and
Focus Catchment Coordinator Brisbane River)

Ms Carolyn Young

NSW Dept of Land & Water Conservation
PO Box 189
Queanbeyan NSW 2620
Tel.: (02) 6299 7688
Fax: (02) 6299 7766
Email cyoung@dlwc.nsw.gov.au
(Focus Catchment Coordinator Murrumbidgee River)

COOPERATIVE RESEARCH CENTRE FOR
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CRC

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CSIRO Land and Water
Department of Land and Water Conservation, NSW
Department of Natural Resources, Qld
Department of Natural Resources and Environment, Vic
Goulburn-Murray Water
Griffith University
Melbourne Water
Monash University
Murray-Darling Basin Commission
Southern Rural Water
The University of Melbourne
Wimmera Mallee Water

Associates: Hydro-Electric Corporation, Tas • SA Water • State Forests of NSW •

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

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

http://www.catchment.crc.org.au