NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 121 OCTOBER 2003

A NOTE FROM THE DIRECTOR

Professor Rob Vertessy

Inside...

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

Building capacity in catchment prediction

In the March 2003 edition of *Catchword* (Issue 114: 'Landscape renewal and catchment prediction') I wrote about the importance of catchment prediction in natural resources management. In that article I highlighted our ambition to equip government, and by extension the community, with the capability to predict the hydrologic and related consequences of land and water management actions. So pivotal is this aspiration for us, it is embodied in our mission statement: 'To deliver to resource managers the capability to assess the hydrologic impact of land-use and water-management decisions at whole-of-catchment scale'.

Many of you will have since read or heard about the Catchment Modelling Toolkit initiative (see www.toolkit.net.au for further information). The Toolkit is a vital ingredient in our strategy to deliver the predictive capability referred to in our mission statement. However, irrespective of the utility of any modelling software that gets incorporated into the Toolkit, it will be of limited usefulness unless there is a sizeable group of capable model users. The fact is that catchment modelling expertise in Australia is pretty thin and requires a major boost. In short, we need to do more than just develop models and test them; we see training for model users as vital.

Whilst the Toolkit is in the early stages of development (but now beginning to grow fast), we have turned our attention to the major challenge of building capacity within the land and water industry - to apply it. The first step we took was to launch a series of five 'Development Projects'. These projects are run by teams in our industry Parties and entail the application of our whole-of-catchment modelling tools to practical land and water management issues in our five focus catchments. The Toolkit team, led by Joel Rahman, has provided targeted training to the 15 or so 'crack' agency staff involved in the Development Projects and got them off to a flying start. In time, those staff will train others within their organisations to apply the modelling tools developed by our CRC. To complement this internal training, we are now casting our net wider and planning a Catchment Modelling School, the first we hope of several to follow.

This initial Catchment Modelling School will be held during 9-20 February 2004 at the University of Melbourne. In 'The Flow on Effect' in this issue of *Catchword*, David Perry discusses the School in detail, but I'll summarise a few key points here.

The School will be modular in format and will include seminars and workshops provided by many of Australia's leading catchment modellers. Over the ten-day period there will be over a dozen short-and-sharp seminars on various catchment modelling topics. Some of these will be tailored to non-specialists in an attempt to de-mystify what is regarded by many as an esoteric activity. The mainstay of the School however will be a series of hands-on workshops where participants will be trained in the use of various hydrologic (and related) models. Instruction will be offered in the use of over 20 different models, many of which will be obtainable free of charge or at low cost from the Toolkit web site. We won't be restricting the School to CRC-developed models as there are many fine products developed by other groups which we would like to see adopted in the land and water management industry. We are inducting experts from other organisations to provide tuition in the use of these tools.

Although the School is now in an advanced stage of planning, we are yet to finalise the program. Before we do that we want to gauge end-user needs, so we are now seeking expressions of interest from potential participants. If you have an interest in the School I urge you to visit our web site at www.toolkit.net.au/school and rate the various modules we are considering presenting. As an incentive, those of you who express interest early in particular modules will have a greater chance of getting enrolled in them.

For those of you in leadership roles in natural resource management agencies I hope you will consider sending your staff to participate in the Catchment Modelling School. The School is a great way to be mentored by some outstanding catchment modellers, and to become proficient in the use of leading-edge modelling tools. Participation in the School will also provide unparalleled opportunities for your staff to network with like-minded professionals in aligned agencies. The Australian land and water management industry needs a strong and coordinated catchment modelling community. I hope you will join with us in creating one.

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CRC PUBLICATIONS LIST

A complete list of all documents and products produced by the CRC since 1993 is available at our web site at www.catchment.crc.org.au/publications

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Report by Geoff Podger, Rodger Grayson and Joel Rahman

Visualisation of uncertainty

Introduction

Models are increasingly used to develop catchment management policies, manage catchments, assess impacts of changes across the whole of catchment and also provide a better understanding of how catchments function. Traditionally modellers have been careful in how they present model results. They take into account the uncertainty in the underlying data as well as the uncertainty in the calibration of the particular model. Care is taken in the selection of published parameters and the number of significant figures provided. Another technique is to ignore the uncertainty in the underlying data and look at the relative differences between models. In this case results are presented as proportional or percentage changes between model configurations.

Models are becoming increasingly more complex and are starting to be used to investigate actual catchment behaviour rather than relative change. With this increased complexity and reliance on absolute numbers, modellers need to communicate the uncertainty of data and models to managers. This is something that has traditionally been ignored by modellers as it can be extremely difficult to quantify. It becomes even more difficult when models are connected.

A task within Project 1.9 (1B): 'Implementation of the Catchment Modelling Toolkit' is to identify methods for representing and communicating the uncertainty and risk in the CRC for Catchment Hydrology modelling tools. This article discusses some of the ideas that we have come up with for displaying uncertainty. Note that this article is not about how to define uncertainty in particular predictions, nor how to accumulate uncertainty through a model, but rather how to display uncertainty to the user, irrespective of how it is defined.

Visualisation tools

It is assumed that each toolkit product will produce some combination of the following basic types of output information:

- numbers (such as would be presented in tables)
- bar charts
- line graphs (eg time series)
- point information (eg values at a monitoring site displayed on a map as a coloured shape centred on the site)
- lines on a map (eg. colour coded lines along streams representing bank erosion)
- maps (as rasters or polygons)

The proposition is to use the same basic method for displaying uncertainty in all cases.

- Uncertainty block

The notion is that the uncertainty is displayed as a coloured block ("uncertainty block"), as shown in Figure 1.1. The colour saturation is a function of the uncertainty around the expected value. A bold colour indicates a high frequency of occurrence while a light colour indicates a low frequency. The edge of the block could be defined by the 95% confidence limits.

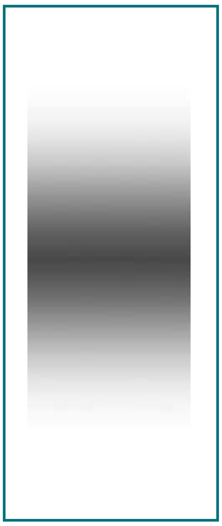

Figure 1.1 Uncertainty block

The definition of the distribution of saturation for the uncertainty block could be handled by using a single flexible functional form, the parameters of which could be chosen to emulate standard statistical functions or anything else. There is no need for the distribution to be symmetrical. In the first instance we will use the Burr distribution which has just two parameters and offers a very flexible function that can go close to representing the Normal, as well as asymmetrical distributions.

- Showing or displaying number uncertainty

The presentation of numbers would always be accompanied by an uncertainty block with the values of the 95% confidence limits displayed to the right of the block, as shown below.

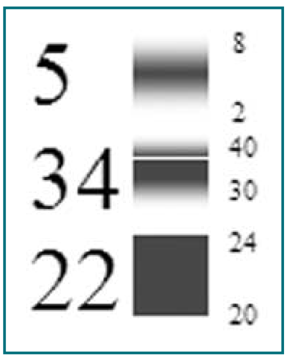

Figure1.2 Displaying number uncertainty

Here the distribution of uncertainty around the median 23 is uniform and the range is 20-24 - i.e. any value from 20-24 is equally likely. The distribution around 5 is tighter than around 34 (i.e. the central band is broader in the latter).

- Bar charts

The uncertainty block can also be applied to bar charts as shown in Figure 1.3. The standard bar as shown in (i) will be replaced with a uncertainty bar as shown in (ii). The width of the bar could increase with greater uncertainty, as shown in bar (iii).

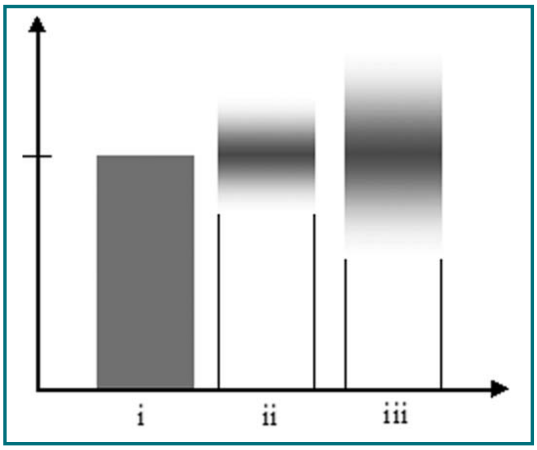

Figure 1.3 Displaying uncertainty in bar charts

- Uncertainty in line graphs

Single lines on line graphs would be replaced by a broad band coloured in the same way as the figure above. The distribution of uncertainty could be specified for every series value. For example if the series was streamflow, there may be lower uncertainty at times of low flow than at times of peak flow as shown in Figure 1.4.

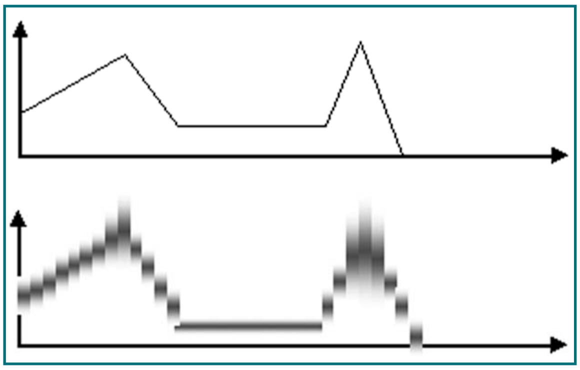

Figure 1.4 Displaying uncertainty in line graphs

Any information that has a location in space and is mapped presents a problem due to the increased number of dimensions - it is not possible to directly use the same idea where the uncertainty range and distribution are simultaneously indicated. Instead it is proposed that the level of colour saturation in a feature such as a pixel, polygon, line segment, or point be used to indicate the overall uncertainty (eg range from 95%-5%, interquartile or whatever), and that as a pointer is rolled over the feature, an uncertainty block appears to enable the absolute values for that feature to be interrogated.

- Uncertainty on maps

Figure 1.5 shows a set of pixels, where the hue represents the value of the pixel, the colour saturation (depicted as density of stipples) represents the overall uncertainty, and for the item with the pointer (two shown here), an uncertainty block appears indicating how that overall uncertainty is distributed across the range.

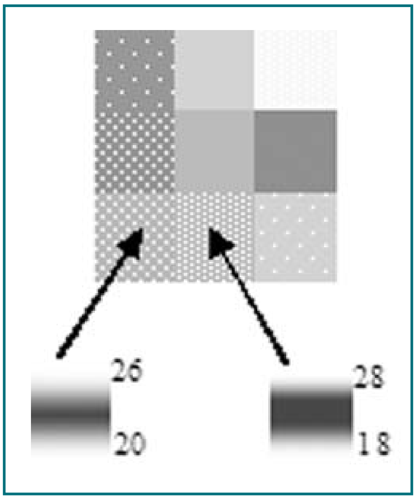

Figure 1.5 Displaying uncertainty on maps

Storing uncertainty information with data

To be able to display uncertainty the data structures used in TIME will need to support carrying uncertainty information about each datum. The most efficient method for doing this is to use a simple form function that approximates the probability density function (pdf) of the datum. The Burr distribution has the smallest overhead with only four additional parameters needing to be stored with each datum. Two parameters describe the Burr distribution (c,k) while an additional parameter is used to remove the shape dependency of each datum (B). A further parameter will be needed to describe whether the error is relative or absolute.

The pdf is given by:

$$f_x(x) = \frac{ck(\frac{1}{\beta}x)^{c-1}}{(1+(\frac{1}{\beta}x)^c)^{k+1}};x>0$$

and cdf is given by:

$$F_x(x) = 1-\frac{1}{(1+(\frac{1}{\beta}x)^c)^k};x>0$$

The advantages of using this approach are:

- being three parameter, it is easily fitted if all we have is some information on percentiles.
- it is sufficiently flexible to represent common statistical distributions well enough for illustrative purposes.

NEW TECHNICAL REPORT

Estimating Water Storage Capacities in Soil at Catchment Scales.

By

Neil McKenzie
John Gallant
Linda Gregory

Technical Report 03/3

Landscapes vary in their capacity to store water. Estimates of water storage capacities in soil are required to allow a better analysis of interactions between vegetation and stream flow from local to regional scales. This is particularly relevant to simulation studies relating to dryland salinity, farm forestry and water security. This report investigates how land resource data can be used to improve estimates of water storage capacities in soil at catchment scales.

Printed and bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

www.toolkit.net.au

The Catchment Modelling Toolkit web site has been completely revised. The Toolkit web site will be used to deliver for the CRC for Catchment Hydrology's modelling software and supporting documentation over the next three years.

MUSIC users can now access a range of supporting information at www.toolkit.net.au/music

For further information visit www.toolkit.net.au

Comments and queries can be directed to David Perry tel: 03 9905 9600 email: david.perry@eng.monash.edu.au

- it can be directly transformed to enable generation of random variables based on the distributional shape (so for example Monte-Carlo analysis would be simple).

The difficult task is to associate all model inputs and outputs with pdf's. For example one of the common inputs to models is flow data. This is usually height information collected by a pressure transducer and converted to flow by a rating curve. Given a hydraulically stable site there is uncertainty in water density, instrument error at each stage and potentially the largest error, converting from height to flow. A pdf would need to be estimated for the various stages that the gauge operates over then the appropriate pdf would then need to be associated with each datum. Similarly this would need to be done with other inputs such as rainfall, evaporation and salinity.

The next task is to come up with a method of estimating how uncertainty in these observed and other inputs propogate through models and how they shape the pdf's of the model outputs.

Rollout

The communication of model uncertainty, using these techniques, will start to appear in Toolkit products released next year. These basic techniques will first be encoded as reuseable components within TIME, making them available to all Toolkit model developers.

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PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Mark Littleboy

Project 2.21 (2C) - Predicting salt movement in catchments

Background

This project focuses on the development of a consistent salt balance modelling approach that can be applied at a catchment scale across eastern Australia. It is co-funded by the CRC for Catchment Hydrology and the Murray-Darling Basin Commission. This new salt balance model will provide the capability to CRC for Catchment Hydrology industry Parties to provide consistent predictions on salt movement. It also aligns salinity modelling activities between the eastern States and CSIRO.

The activities in this project are designed to supplement, rather than replace, existing salt balance modelling within CSIRO and the three industry Parties (Victoria DPI/DSE, NSW DIPNR and Qld DNRM). It builds on the existing collaborative linkages and provides a platform to share skills and resources across each of the organisations

Project aim and outcomes

The objective of Project 2.21 (2C) is to develop a salt balance model for CRC for Catchment Hydrology industry Parties that will provide consistent output across these agencies as part of their State, Murray-Darling Basin and national investment, catchment planning and reporting mechanisms. Outcomes from the project will:

- quantify surface and groundwater contributions of salt to catchment scale salt export;
- predict the impacts of land-use change on salt movement at a catchment scale;
- link with other models within the CRC for Catchment Hydrology Toolkit to predict the impacts of salinity management scenarios on downstream water allocations, environmental flows, and their contributions to end-of-valley salinity targets; and
- demonstrate the capability of the model through application in three CRC for Catchment Hydrology focus catchments

Project workshop

The first major activity in Project 2.21 (2C) was a Project Team workshop held 28-30 May 2003 to:

- provide an overview of existing activities across project Parties;
- determine what each agency wants out of the project, how they plan to use the outputs from the project in their organisations, and how the project will fit in with other activities within each organization;
- discuss design specifications of Project 2.21 (2C) salt balance model; and
- obtain agreement on model components and design specifications.

Design specifications for the model

Following this workshop, a report containing the design specifications of the model was produced. This report captures many aspects of past and existing activities across the CRC for Catchment Hydrology agencies. In particular, the CSIRO BC2C Model, the Victorian CAT Model, the New South Wales CATSALT Model, recharge modelling (New South Wales, Queensland and Victoria) and the CSIRO conceptual "Three Stores" groundwater model.

Upon reflection, the workshop successfully defined design specifications of the Project 2.21 (2C) salt balance model, obtained agreement on model components and structure, and developed an overview of work plans and responsibilities of project team members. It was clearly evident that Project 2.21 (2C) builds on existing modelling tools. The project is a major opportunity to learn from other groups, exchange ideas, identify commonalities, and work towards standardisation across States. We are not trying to deliver a suite of tools to do "everything". The emphasis is to build one tool well - in line with project objectives.

Evolving design concepts for model

The generic design concepts as listed in the original Project Agreement were that the model:

- focuses on dryland salinity processes rather than irrigation salinity;
- should be applicable to catchments up to 2000 km^2;
- predicts the impacts of land-use changes within catchment on end-of-catchment hydrology and salt export;
- is underpinned by the previous Groundwater Flow Systems concepts;
- partitions surface and groundwater pathways of water and salt;
- predicts transitional phases of land-use change; and
- operates on a daily timestep

MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

A Critical Review of Paired Catchment Studies with Reference to Seasonal Flows and Climatic Variability.

By

Alice Best
Lu Zhang
Tom McMahon
Andrew Western
Rob Vertessy

Technical Report 03/4

This report focuses on the use of paired catchment studies as a means for determining long-term changes in water yield as a result large scale changes in vegetation. Current knowledge gaps in relation to the impacts of broad scale vegetation changes on flow regime and seasonal flows are highlighted and possible methods of addressing these gaps are suggested.

This report is available as an Adobe .pdf file only.

Visit www.catchment.crc.org.au/ publications and search under 'Land-use Impacts on Rivers'

MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

Impact of Increased Recharge on Groundwater Discharge: Development and Application of a Simplified Function using Catchment Parameters.

By
Mat Gilfedder
Chris Smitt
Warrick Dawes
Cuan Petheram
Mirko Stauffacher
Glen Walker

Technical Report 03/6

This report describes the development of a simple approach towards estimating the response of groundwater systems to changes in recharge that arise from changes in land-use. The emergent properties of a groundwater system are examined using scaling arguments, by combining the effect of aquifer properties into a single dimensionless groundwater system similarity parameter (G).

This report is available as an Adobe .pdf file only.

Visit www.catchment.crc.org.au/ publications and search under 'Land-use Impacts on Rivers'

Two additional design concepts evolved or were confirmed during the Design Workshop:

- The model must integrate with the node-link hydrological models within the CRC's Catchment Modelling Toolkit. This is required so that the impacts of land-use change within a subcatchment can be assessed across scales. That is, at the end of the subcatchment, and further downstream for the assessment of mid-valley and end-of-valley targets.
- The model must link "scenario" modelling and "trend" modelling. This is a major challenge for the Project that evolved during contract discussions with MDBC on co-funding arrangements. A "scenario model" predicts the impacts of a land-use change on a 25 year daily time series of streamflow and salt at the subcatchment outlet. A "trend model" predicts future saltload trends, commonly using the "rising watertable" type model. In Australia, these are currently separate modelling activities that must now be linked within Project 2.21 (2C).

Overall model design
The overall design of the model is summarised in Figure 2.1 (courtesy of some of Warrick Dawes magical pragmatism during the workshop).

Each of the four boxes in Figure 2.1 is referred to as a "model hook" rather than a model component. In this way, different algorithms can be "hooked" into the model.

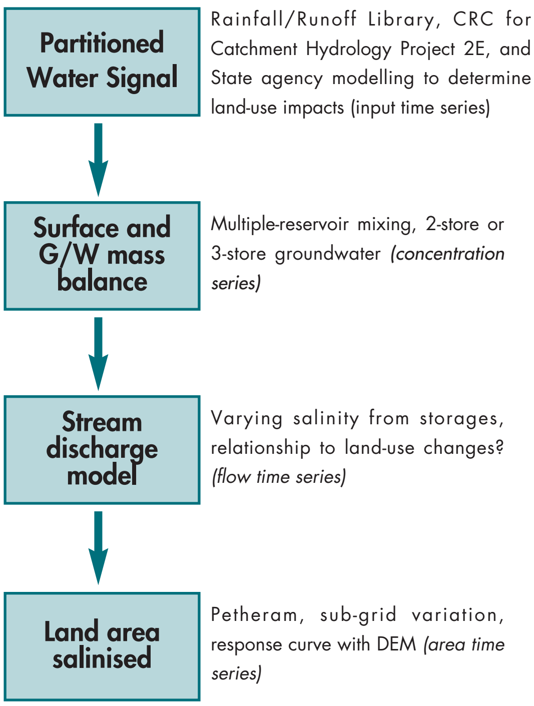

Figure 2.1: Schematic overview of the 2C salt balance model.

- Partitioned water signal
The first model hook, partitioned water signal, supplies a daily time series of hydrology partitioned into its various components (e.g. surface runoff, baseflow and recharge). It is essentially a mass balance of water volumes.

- Surface and groundwater mass balance
The second model hook, surface and groundwater mass balance, uses the partitioned water signal to derive a time series of concentrations of salt from surface washoff and groundwater stores.

- Stream discharge model
The third model hook, stream discharge, is a simplified groundwater model that provides a daily time series of flow and salt from different storages in a catchment. Storages include surface, soil unsaturated zone, shallow groundwater and alluvial aquifers.

- Land area salinised
The fourth model hook, land area salinised or affected by shallow watertables, is the component that permits the model to assess the impact of land-use changes on future salt trend lines. Once quantified, the changes in areas affected by shallow watertables can be integrated with existing future saltload analysis tools to determine the impacts on future salt load trend lines.

The model will therefore quantify the key question "where in the landscape do you do a land-use change?" in two ways. Firstly, the impacts at end of catchment with respect to streamflow, stream EC and saltloads. Secondly, the impacts on future salt load trends which must be based on prediction of change in areas affected by shallow water tables within a catchment.

Challenges ahead
Two challenges need to met within Project 2.21 (2C). The first is naturally addressing the scientific issues that will arise during the construction and testing of the model. The second is breaking down any organisational barriers to ensure consistency across three different State agencies and CSIRO. Both are quite achievable, especially given the level of involvement, enthusiasm and openness by all participants at the May workshop.

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PROGRAM 3
SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Bringing EMSS into the economic laboratory: A biophysical economic experiment

Background

This article reports on research in the Brisbane focus catchment evaluating policy instruments and trading market structures for sediment runoff using an integrated experimental/biophysical model. The model integrates an environmental management support system (EMSS), developed by CRC researchers in Program 1 for modelling sediment runoff in catchments, with an experimental economic environment designed to explore resource economic issues and policy options under laboratory conditions by researchers in Program 3.

The research using the integrated model explored the relative performance of closed call tenders, of cap and trade, and of regulation as mechanisms for achieving reductions in total suspended solids (TSS) exiting the Somerset Stanley Catchment of Queensland.

Uniform price closed call auctions

A uniform closed call auction involves farmers with riparian lands tendering for riparian buffer funding from a central agency. The central agency takes the lowest price bid upwards until the reduction target is met or the budgetary constraint is met. Each successful seller is then paid the same (uniform) price - the bid price of the last accepted bid. Cason and Plott (1996) found in a study of the USEPA emission-trading scheme that the uniform price call auction is more efficient, provides more accurate price information and was more responsive to changes in market conditions than a discriminative price auction. In their study buyers and sellers were interacting. In this case there is only one buyer. In such situations it is possible that the buyer, the authority in this case, may also exploit its single buyer or monopsony power by introducing a discriminative price closed call auction structure.

Cap and trade

An alternative policy is to introduce a cap and trade scheme. Cap and trade, as the name suggests, involves a regulating authority imposing an upper limit on the level of production or in this case pollution. Producers trade in pollution credits to achieve the cap at minimum cost provided standard market requirements, such as low transaction costs, are met. The notion of cap and trade implies that each player can potentially be a buyer or seller. When the market price is below their marginal cost of production they are expected to enter the market and buy units rather than producing them. When the market price is above the marginal cost of producing beyond the target quantity, the player is expected to exceed their target production level and sell the additional units.

Regulation

A third policy option is to regulate riparian land management. The regulatory approach explored in this paper involves a requirement that riparian landholders install riparian buffer strips on each stream level on a proportional basis. In other words, if the TSS target were 10% of current TSS, then each farmer would be required to have riparian buffers on at least 10% of each level of stream flowing through their lands. The regulation results in a reduction of supply by each of the traders and a decrease in supply relative to the market supply curve.

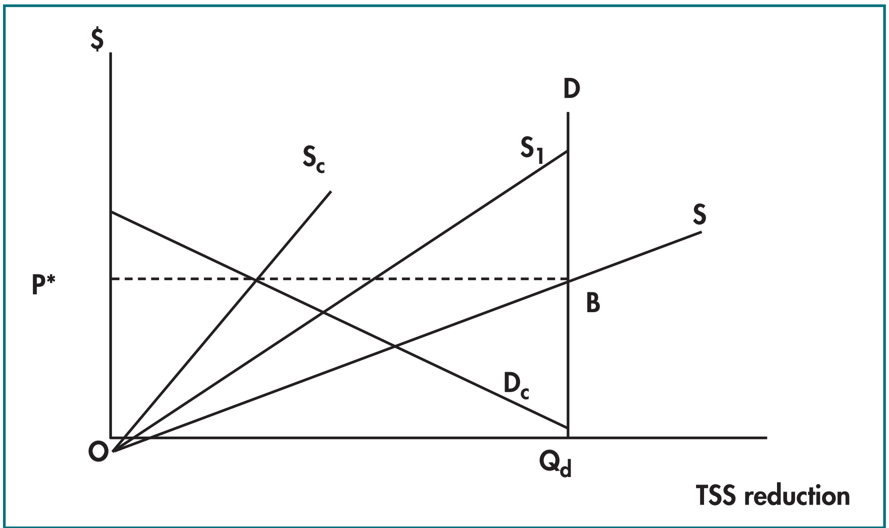

Figure 3.1 Hypothesised comparison of command and control, cap and trade and uniform price tendering

MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

Modelling the Effectiveness of Recharge Reduction for Salinity Management: Sensitivity to Catchment Characteristics.

By
Chris Smitt
Mat Gilfedder
Warrick Dawes
Cuan Petheram
Glen Walker

Technical Report 03/7

This report describes the use of modelling to investigate the sensitivity of groundwater and other characteristics on the effect of recharge reduction on salinity management.

This report is available as an Adobe .pdf file only.

Visit www.catchment.crc.org.au/ publications and search under 'Land-use Impacts on Rivers'

MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

Testing In-Class Variability of Groundwater Systems: Local Upland Systems.

By

Cuan Petheram
Chris Smitt
Glen Walker
Mat Gilfedder

Technical Report 03/8

This report assesses the extent information can be transferred between hydrogeologically similar catchments, by investigating in detail one set of similar catchments.

This report is available as an Adobe .pdf file only.

Visit www.catchment.crc.org.au/publications and search under 'Land-use Impacts on Rivers'

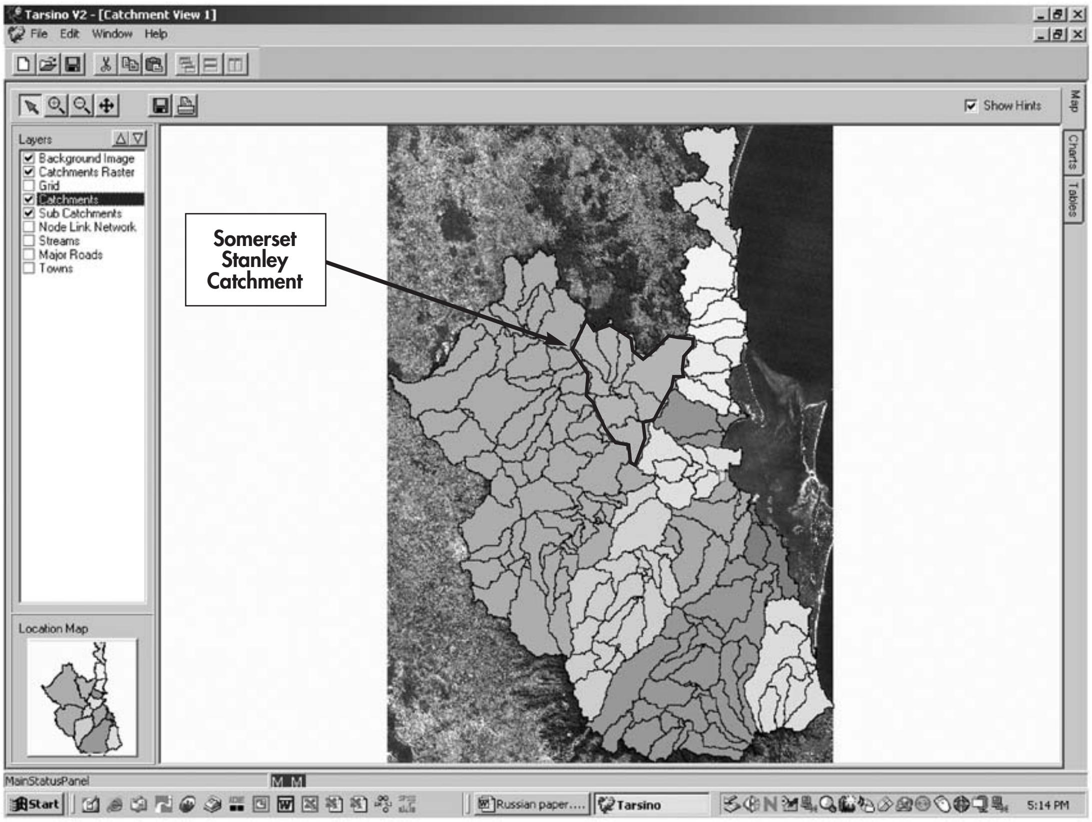

Figure 3.2. Somerset Stanley Catchment in EMSS

The simplified version of the problem stems from the relative size of the revenue returned to the farmers from a uniform price auction compared to the cost of achieving a regulative instrument. In Figure 3.1, supply (S) reflects the combined marginal cost of sediment reduction of each of the sub-catchments. It is assumed that it is possible, through regional farming associations, to coordinate land use within a sub-catchment. Setting a reduction target Q_d opens a number of possible policy incentives. First, the authority could establish a uniform price tendering system, resulting in a market price p*. Alternatively, the government could impose a command-and-control requirement that each farmer establish buffer strips to capture total suspended solids (TSS) proportional to current aggregate loads, resulting in S_1. Furthermore, the government could introduce a discriminatory price closed call tender resulting in potential capture of producer surplus.

In this case study, the focus was on the sediment released from the Somerset Stanley Catchment (Figure 3.2). The catchment is important, as it is the main catchment for Summerset and indirectly Wivenhoe dams. Wivenhoe dam is the main storage for Brisbane's water supply.

Data generation

EMSS has up to five types of streams in each sub-catchment, from major rivers to ephemeral. For each there is a distance of riparian land. For each it is possible to set a sediment loading threshold rate (SLTR) expressed as tonne/km/day. In this study the SLTRs for the five stream types were set at 1, 0.8, 0.6, 0.4 and 0.2 respectively. The notion is that level 1 streams (large rivers) will have a higher load rate than smaller streams. Simulations in EMSS were run and data captured for each stream type in each sub-catchment to end of catchment loads[3.1]. EMSS has two riparian treatments levels, superior and standard. The modelling used superior riparian buffer management which results in a one-tonne per km per day sediment loading rate at sill (compared to a 0.1 loading for standard riparian buffer management). The catchment, consisting of 11 sub-catchments is in the upper northern section of the Brisbane Valley. EMSS simulations were run for each type of stream in each of the 11 sub-catchments. The cost of riparian buffer per kilometre was assumed constant throughout the catchment at A$475. The simulated load reductions were used to estimate unique cost functions per unit of sediment reduction for each stream.

Experimental design

Three experiments consisting of ten-repeated trade periods for each of the policy treatments were

[3.1] At present EMSS treats riparian total suspended solid loads at a block conceptual sub-catchment level. Development of the model to site-specific contributions is underway and expected to overcome many of the problems associated with the management of non-point pollution of this nature.

conducted. Each session used eleven students, one trading units for each sub-catchment in the Somerset Stanley Catchment. The EMSS modelled estimate of the amount of total suspended solids exiting the catchment was 73,000 tonnes per day. The experiment assumed a target reduction of 10,000 tonnes per day. The necessary software was developed and the experiments conducted at the Griffith University Experimental laboratory in Brisbane.

Results and implications

In the experimental setting the uniform price tender system resulted in higher than expected market prices, which in turn (a) reduced the level of market efficiency, and (b) significantly increased the cost to the authority. The cap and trade experiments produced high levels of convergence and market efficiency. Regulation was found to be more cost effective than a uniform price tender system, but more expensive and less efficient than a cap and trade auction system. The results question a commonly held view by policy makers that a uniform tender system will be equally efficient as a cap and trade instrument.

The complete study and associated findings have been presented in Brisbane to BCC, DNRQ, SEQ Water and the Moreton Bay Waterway and Catchment Partnership. A presentation is being planned for Canberra in the next few months.

Reference

Cason Timothy N., Plott Charles R., 1966 'EPA's New Emissions Trading Mechanism: A Laboratory Evaluation, Journal of Environmental Economics and Management 30, 133-160 (1996) [3.2]

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MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

Assessment of Salinity Management Options for Kyeamba Creek, New South Wales: Data Analysis and Groundwater Modelling.

By

Richard Cresswell
Warrick Dawes
Greg Summerell
Geoff Beale
Narendra Tuteja
Glen Walker

Technical Report 03/9

This report describes a study of the hydrogeological factors influencing salinity in the Kyeamba catchment, located within the uplands of the Lachlan Fold Belt of south-eastern Australia.

This report is available as an Adobe .pdf file only.

Visit www.catchment.crc.org.au/publications and search under 'Land-use Impacts on Rivers'

[3.2] The Goulburn Simulation Model (GSM) has been described in more detail in the May 2003 issue of *Catchword* (116).

URBAN STORMWATER SOFTWARE

Model for Urban Stormwater Improvement Conceptualisation (MUSIC)

MUSIC is a decision-support system. The software enables users to evaluate conceptual designs of stormwater management systems to ensure they are appropriate for their catchments. By simulating the performance of stormwater quality improvement measures, music determines if proposed systems can meet specified water quality objectives.

MUSIC is available from the Centre Office for $88.00

Individuals will need to sign a Licence Agreement (available from the Centre Office and website: www.catchment.crc.org.au)

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

Please note: MUSIC version 1.00 is a development version and will be valid until December 2003. The CRC for Catchment Hydrology is committed to updating MUSIC annually until at least 2006. Subsequent versions of MUSIC may be charged for.

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader TIM FLETCHER

Report by Muthukumaran Muthukaruppan, Francis Chiew, Tony Wong

Characterisation of suspended solids in urban stormwater

Introduction

This article presents a summary of the results from field investigations on the characteristics of suspended sediments in urban stormwater. The aim of this study was to investigate the particle size distribution (PSD) and the pollutant distribution over different size ranges (SDP) in urban runoff. This research focused on the suspended solids, two nutrients (TP and TN) and four trace metals (Zn, Pb, Ni and Cu). The influence of geology on the characteristics of the pollutants was also investigated by selecting two catchments each in sedimentary and basaltic geology in Melbourne (as well as a catchment in Brisbane).

Characteristics of dry surface solids

The PSD and SDP characteristics were investigated initially through a two-stage monitoring program. The characteristics of dry surface solids were investigated in the four Melbourne catchments as a scoping study. In addition to the determination of PSD and pollutant concentrations in the various particle size ranges, the dry solid samples were also subjected to a sequential extraction procedure to fractionate soluble (water extractable), mobilisable (dilute hydrochloric acid extractable) and particulate residual (strong acid digestion) contents. The results suggested that pollutant loads were likely to be higher in the basaltic areas and that the basaltic areas had finer sediments and higher trace metal concentrations associated with the finer sediments. The results also indicated that even under severe environmental conditions only about two thirds of total pollutant could be mobilised, and out of which only a fraction will be readily bioavailable. Results from this study have been described in more detail in Muthukaruppan *et al.*, (2002).

Characteristics of urban stormwater

The main part of this study involved extensive automatic event stormwater quality monitoring on the four Melbourne catchments and one Brisbane catchment to estimate the characteristics of pollutants transported during storm conditions. Stormwater samples collected from these five catchments were analysed for size distribution of the solids (PSD) and various pollutants (TP, TN, Zn, Pb, Ni, and Cu).

The PSD investigations of the solids in the stormwater provided further evidence that the basaltic catchments generated finer particles than the sedimentary catchments in Melbourne (see Figure 4.1). Within a catchment, there was not much difference between the PSDs for different storms. The analyses of the PSD indices showed that runoff characteristics mainly influenced the transport of coarser particles and had

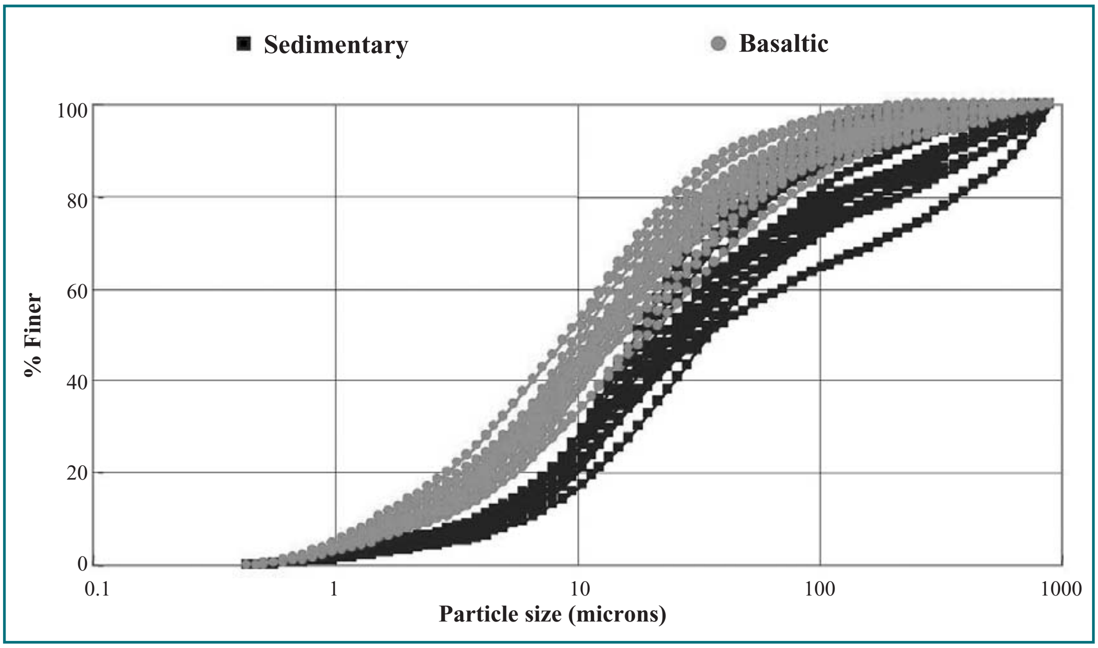

Figure 4.1 Particle size distributions for all the monitored events (the same marker is used for the two basaltic catchments and the same marker is used for the two sedimentary catchments)

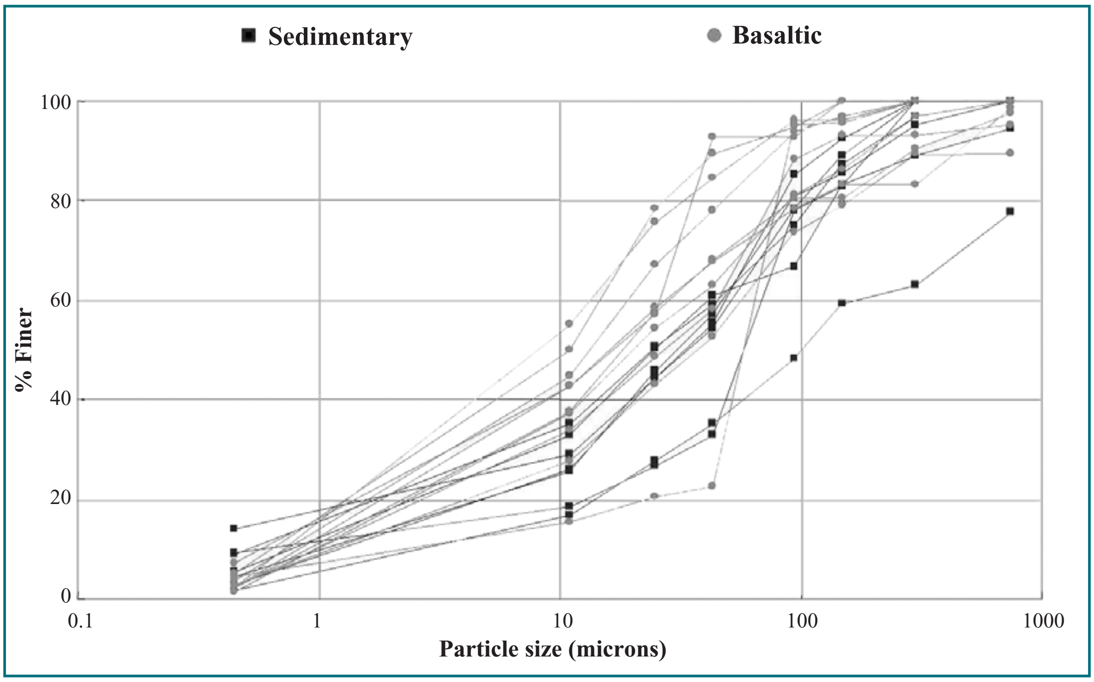

Figure 4.2 Size distribution of pollutants for all the monitored events (the same line is used for the two basaltic catchments and the same line is used for the two sedimentary catchments)

little influence on the transport of finer particles. The results also indicated that PSD became finer through the event, with the larger particles dominating the rising limb of single peak events. However, for multi-peak events the PSD became coarser during each rising limb and then finer during the recession. This put into question the notion of the first flush phenomenon in stormwater pollutant washoff, and provided further evidence that detailed modelling of buildup was not necessary since there were always enough materials available for transport. Pollutant generation was therefore not source limiting and its characteristics depended mainly on the mobilising forces.

A serial filtration technique, which involved passing the stormwater sample sequentially through a range of sieves and filter papers with aperture sizes ranging from 750 to 0.45 (µm, was used to determine the SDP. Specially made plastic sieves with nylon sieve clothes were used in order to avoid contamination by metals. The SDP curves for Pb from the four Melbourne catchments are shown, as an example, in Figure 4.2.

The SDP envelopes showed considerable variability for all the pollutants. In general, it was expected that pollutant concentration per unit mass of particles would increase with decreasing particle size. However, this trend was not as strong as anticipated with several of the SDP envelopes coarser than the PSD indicating higher concentrations at the coarser particle size ranges. Increasing particulate pollutant concentration with decreasing particle size occurred mostly where dissolved pollutants had adsorbed onto particulate surfaces. For example, in situations where particulate pollutants had not passed through the dissolved phase, such as Zn and Cu in small pieces of tyre rubber and brake lining materials, the particulate concentrations may not have increased with particle size.

Geology aspects

In regard to catchment geology, the basaltic catchments exhibited larger variability compared to the sedimentary catchments. With the exception of TN, the SDP for all other pollutant showed that 60% to 90% of the total pollutant loads were in the 750 to 0.45 µm size range. The SDPs of the sedimentary catchments showed that up to 50% of pollutants were associated with the particles in the 750 to 43 µm size range, which approximately represented the range of particles that were normally removed through the physical removal processes during storm events. However, the particles in this size range from the basaltic catchments carried relatively lesser pollutant load and the finer than 43 µm size fraction carried most of the particulate bound pollutants. This has significant management implications since stormwater treatment facilities have to be designed using different design criteria in order to achieve similar pollutant load reductions in catchments with different geology.

Summary results

The summary results from this study are useful for various modelling and design applications. For example, the SDP curves (such as in Figure 4.2) can be used in

MUSIC TRAINING - REGISTER YOUR INTEREST

As part of the Catchment Modelling School planned for 9-20 February 2003, a two day basic and a one day advanced MUSIC training workshop is being offered to MUSIC users.

The Catchment Modelling School will be held at The University of Melbourne and we are inviting potential participants to register their interest at www.toolkit.net.au/school

Your expression of interest in MUSIC and other training workshops will enable us to design the School agenda to meet industry needs.

PLEASE NOTE: Preferences for popular workshops will be given to those who have registered their interest before Friday 7 November 2003

www.toolkit.net.au/school

NEW TECHNICAL REPORT

Predicting the Effects of Large Scale Afforestation on Annual Flow Regime and Water Allocation: An Example for the Goulburn Broken Catchments.

by

Lu Zhang
Trevor Dowling
Mark Hocking
Jim Morris
Geoff Adams
Klaus Hickel
Alice Best
Rob Vertessy

Technical Report 03/5

This report bridges part of the gap between the science of catchment water balances and the management of catchments.The language has moved from "annual average yield " to "water security". Afforestation and water remains a contentious issue. This report sets out an important case study to underpin future decision-making.

Printed and bound copies of this report are avialable from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

models to estimate the amount of pollutants in the various size ranges in different geologies, and as a preliminary design tool to help size ponds and wetlands designed to achieve particular objectives.

Reference

Muthukaruppan, M., Chiew, F., Wong, T., 2002. Characterisation of Urban Street Surface Solids, Hydrology and Water Resources Symposium 2002 [CD-ROM]. IE Aust, Melbourne, Australia, 8pp.

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PROGRAM 5

CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Sri Srikanthan and Francis Chiew

Stochastic generation of spatial daily rainfall

Stochastic modelling in Project 5.2 and Project 5.06 (5B)

Stochastic models for generating point rainfall and climate data at annual, monthly and daily timescales have been developed in the first part of the Climate Variability Program under Project 5.2: 'National data bank of stochastic, climate and streamflow models' and Project 5.06 (5B): 'Stochastic rainfall data generation models' in the second part of the program, has four activities. The two major activities in Project 5.06 (5B) are the development and testing of stochastic models of spatial daily rainfall and point sub-daily rainfall. The modelling of sub-daily rainfall was discussed in the previous *Catchword*, while this article presents the spatial daily rainfall modelling studies that will be carried out in Project 5.06 (5B).

Stochastic models of spatial daily rainfall

Rainfall data at a number of sites over large regions are required as inputs into water system models such as IQQM and REALM, to simulate present conditions as well as changes in system behaviour as a result of changes in climate and catchment characteristics and in management practices. Climate can vary considerably from year to year, and stochastic data provides a means for quantifying the uncertainty in the hydrological system as a result of climate variability. To model a large region realistically, stochastic rainfall models must quantify the spatial dependence between rainfalls across the region.

Compared to stochastic point daily rainfall models, spatial daily rainfall models are much less common. Spatial daily rainfall models can be broadly grouped into three categories: extension of Markov chain models; conditional models; and random cascade models. Based on a recently completed review of the literature in Project 5.06 (5B), two models are selected for testing and further development: the extension of single site Markov chain models of Wilks (1998); and the random cascade model of Jothityangkoon *et al.* (2000).

Wilks (1998) extended the familiar two-part model, consisting of a two-state, first-order Markov chain for rainfall occurrences and a mixed exponential distribution for rainfall amounts at multiple locations. The rainfall occurrence and depth are generated simultaneously at multiple locations by driving a collection of individual models with serially independent but spatially correlated random numbers.

Jothityangkoon *et al.* (2000) constructed a space-time model to generate synthetic fields of space-time daily rainfall. The model has two components: a temporal model based on a first-order, four-state Markov chain which generates a daily time series of the regionally averaged rainfall and a spatial model based on nonhomogeneous random cascade process that disaggregates the above regionally averaged rainfall to produce spatial patterns of daily rainfall. The cascade used to disaggregate the rainfall spatially is a product of stochastic and deterministic factors, the latter enables the model to capture systematic spatial gradients exhibited by measured data.

Development and testing of stochastic spatial daily rainfall models

These two stochastic spatial daily rainfall models will be evaluated and further developed using daily rainfall data from all the focus catchments. Some preliminary work on the Yarra catchment with the two-part model has shown promising results.

The outcome from this activity in Project 5.06 (5B) is the incorporation of a stochastic spatial daily rainfall model in the stochastic model library in the CRC's Catchment Modelling Toolkit.

References

Jothityangkoon, C., Sivapalan, M. and Viney, N. R. 2000. Tests of a space-time model of daily rainfall in southwestern Australia based on nonhomogeneous random cascades. Water Resources Research, Vol. 36(1): 267-284.

Wilks, D. S. 1998. Multisite generalisation of a daily stochastic precipitation generation model. Journal of Hydrology 210: 178-191.

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WEATHER RADAR CONFERENCE

Sixth International Symposium on Hydrological Applications of Weather Radar

2-4 February 2004
Melbourne, Australia

The major theme of this conference is 'The successful implementation of radar technology for hydrological and quantitative rainfall applications'.

For more information on the symposium, please visit www.bom.gov.au/announcements/conferences/hawr2004 or email hawr2004@bom.gov.au

The conference is supported by the Commonwealth Bureau of Meteorology, the CRC for Catchment Hydrology and the Australia Meteorological and Oceanographical Society

NEW SOFTWARE - CHUTE

www.toolkit.net.au/chute

CHUTE carries out the hydraulic design of rock chutes for stabilising channel beds and is designed for use by professional engineers and managers involved in stream rehabilitation and restoration.

CHUTE is the first of many products that will be available to the land and water industry via the Catchment Modelling Toolkit website at www.toolkit.net.au

The CHUTE software can be downloaded from the Toolkit Members area now at www.toolkit.net.au/members.

For further information including copies of the Rock Chute Design Guidelines, please visit www.toolkit.net.au/chute

PROGRAM 6

RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Channel form and hydraulic habitat: an introduction to Project 6.12 (6B)

Introduction

The form of rivers affects many of the issues of concern to the CRC for Catchment Hydrology, including transmission of flow, sediment and nutrients. It is an important consideration in the design of environmental flow regimes in regulated rivers and is one of the primary factors determining physical habitat. It also has a controlling influence on near-channel groundwater interactions, riparian zone processes and floodplain interactions. Changes to the river form itself and the associated erosion and habitat are one of the potential consequences of altered flow regimes, future land-use change and future climate change.

Project focus

The links between catchments, river morphology, physical habitat and reach hydraulics are the focus of Project 6.12 (6B): ‘Predicting spatial and temporal variations in channel form’. We are developing models of channel form and physical habitat conditions throughout river networks and investigating channel change in response to catchment changes. This is a big task and we only have three years and a handful of researchers. This article discusses the project, its goals and methodology.

SedNet model

A major development in channel form and catchment change is the SedNet model. CSIRO initially developed SedNet for the Land and Water Resources Audit to estimate river sediment loads across Australia. It relates mean annual load throughout the river network to available catchment information including terrain, land use, flow, geology and vegetation cover[6.1]. The clever thing about the development of SedNet was the ability to assemble a sound model which only requires data which is readily available in most catchments. Inevitably the development of such a large-scale model requires simplifications and approximations, but the result is a model which has been widely adopted for catchment-scale studies across Australia. The development of SedNet is proof that broad-scale geomorphic modelling is possible and it has inspired us to model broad-scale patterns in channel form and physical habitat conditions.

Who Cares?

We should explain why we want to model channel form and physical habitat throughout river networks. We believe these models are central to catchment management planning and river restoration. Future hydrological change, predicted by the catchment-scale tools of the CRC for Catchment Hydrology, may cause a response in channel form, either channel contraction or a phase of expansion including bank erosion. These changes need to be examined for us to understand the full implications of future land uses, hydrological regimes and climates. Such changes need to be put in the context of other continuing adjustments to river forms, such as the propagation of sand slugs that continue to migrate through many rivers as a result of past erosion. The interactions between flow, sediment transport and river form largely stream habitat conditions. These are the physical conditions that underpin aquatic ecosystems. Changes to these physical conditions may be beneficial or detrimental to the needs of a range of organisms. These changes need to be predicted to better understand the environmental flow needs of our rivers, and to put environmental flows in the context of other stressors on rivers.

... and what is the scientific value of our research? How does it contribute to knowledge of river processes? We argue that the only way to test the generality of our conceptual models of how channels are shaped by catchment and local factors in the short to medium term is through model validation across a range of catchment types. We can’t run catchment-scale experiments or scale catchments to laboratory sizes. We need to see if our models can explain the patterns in channel form we see across our catchments. Where we have historical data, we can also test our models against historic sequences of channel change. Tests of geomorphic models at this scale are rare with most studies examining individual rivers.

Methods

- Links with SedNet

One of the key features of the modelling toolkit is the ability to integrate models. Channel form and sediment load are related, so our model of channels form will “talk” to SedNet with the potential for channel shape to influence sediment modelling in SedNet and sediment loads predicted from SedNet informing our channel models. The CRC for Catchment Hydrology is rewriting SedNet within the modelling toolkit as part of Project 2.20 (2B): ‘Improved suspended sediment and nutrient modelling through river networks’. This will allow us to build a parallel set of model for Project 6.12 (6B) which draw on the same programming tools and use compatible data formats. Ron DeRose at CSIRO is

[6.1] For more information on SedNet contact Ron DeRose, CSIRO Land and Water, Ronald.Derose@csiro.au working on Project 6.12 (6B) and is also working on the development of SedNet. This was a deliberate ploy to allow us to tap into the SedNet infrastructure.

- Data collation and conceptual models

The initial phase of Project 6.12 (6B) has been data collation and development of conceptual models linking channel form to catchment characteristics. We have assembled a large set of river channel surveys for Victorian rivers (refer to Figure 6.1). This data collation exercise was discussed in the last issue of *Catchword*. Each survey consists of between 3 and 60 cross-sections surveyed to bankfull using a common datum. At the same time, we have been reviewing the literature to develop conceptual models of channel form. As part of this, we are deciding how best to characterise channel form. At this stage we plan to describe channel shape by the relation of width and hydraulic depth with various discharge parameters. Whilst most previous studies have examined width and depth at a cross-section or mean values over a reach, we will be modelling both the mean and coefficient of variation in width and depth for a river reach (which is 0.1 km to 10 km long). These relations could be termed the reach hydraulic geometry. We'll also be modelling bankfull discharge, width and depth and are currently grappling with the practicalities of defining bankfull conditions. SedNet predictions are quite sensitive to bankfull width and depth estimates so our models will improve SedNet predictions.

- Model calibration and validation

In the next phase of the project, Ciaran Harman is calibrating a one-dimensional hydraulic model for each reach in our data base. With these models we'll be able to examine how width and depth varies in a range of river types and sizes. These data will be used to test our models of channel form. At the same time, we are collating input data for our models of channel form. Input parameters are restricted to readily available catchment data such as that used in SedNet. Ron DeRose is collating these data using regional databases for Victoria. The final phase of the project is model validation.

- Victorian data

One feature of the project is that we are primarily using Victorian data sets. This was mainly for reasons of practicality. The project already requires extensive effort in data collation. We also have a large field program to collect data over summer. It was not feasible to include a broader spatial coverage in our data sets. We do hope to be able to test our models on data sets from other regions and rely on our industry partners to provide these test data sets. We are optimistic that results from the Victorian data will be applicable elsewhere; certainly the Victorian river surveys represent a broad range of river types including ephemeral rivers in the north west of the state.

Other Aspects of Project 6.12 (6B)

There are a number of other activities in this research project including:

- relating channel form to physical habitat conditions
- examining historic changes in channel form, and
- modelling bank erosion and the migration of sand slugs.

We'll describe these aspects in later editions of *Catchword*. If you want more information about this project please contact the Project Leader, Mike Stewardson mjstew@unimelb.edu.au

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

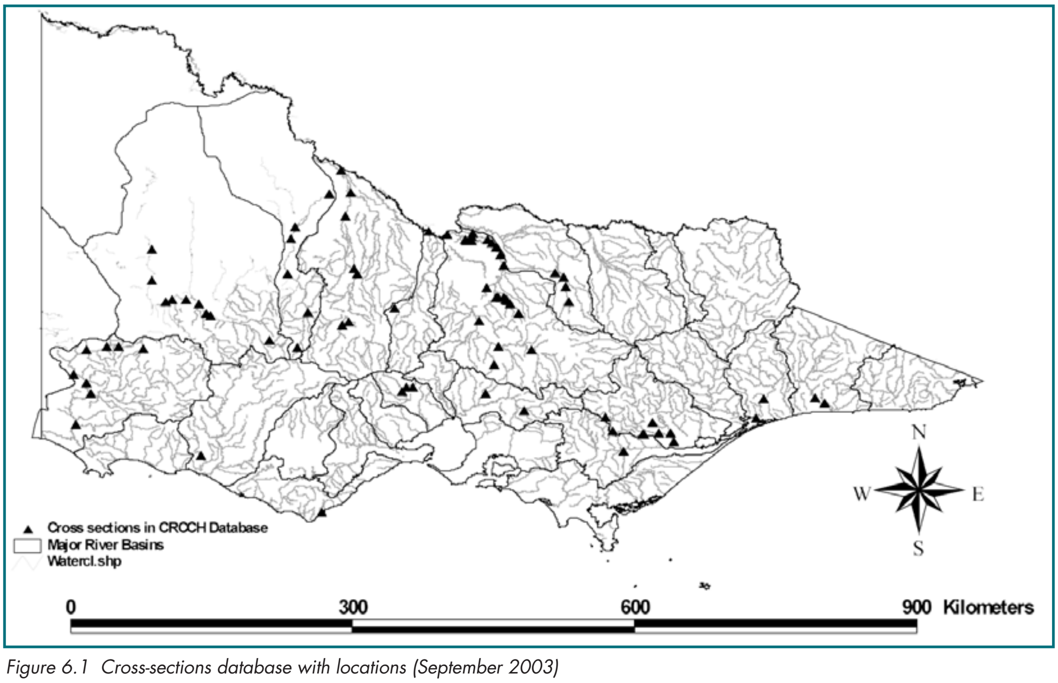

Figure 6.1 Cross-sections database with locations (September 2003)

CATCHMENT MODELLING SCHOOL 9-20 February 2004

The CRC for Catchment Hydrology is proposing to hold a Catchment Modelling School during 9-20 February 2004 in Melbourne, Victoria.

The workshops-based School aims to equip participants with the skills required to undertake and interpret a range of modelling activities relevant to catchment management. Individual workshops based around the latest modelling principles, practices and products will be held during the two-week School and will vary in length from a few hours up to three days.

Please assist us in planning for the School by registering your interest before 7 November 2003

The CRC for Catchment Hydrology needs to know which workshops you would like to attend or are interested in. We will use this information to schedule the Catchment Modelling School timetable to suit as many participants as possible. Please visit www.toolkit.net.au/school for more details.

NOTE: Preferences for popular workshops will be given to those who have registered their interest before Friday 7 November 2003

www.toolkit.net.au/school

CATCHMENT MODELLING TOOLKIT WORKSHOPS

Monday 10 November 2003, Wollongong.

In conjunction with Engineers Australia, the CRC for Catchment Hydrology will be delivering three workshops based on components of the Catchment Modelling Toolkit as part of the International Hydrology and Water Resource Symposium in Wollongong during 10-14 November 2003.

The Toolkit workshops scheduled for Monday 10 November 2003 are:

- Rainfall Runoff Library (RLL) presented by Geoff Podger
- Quantifying Environmental Flows presented by Nick Marsh and Mike Stewardson
- Bed Stabilisation and Stream Crossing Design (CHUTE and MELS) presented by Bob Keller.

Further details are available from www.toolkit.net.au/news

Each workshop is designed to assist participants in understanding the theory and application of the software and includes a hands-on session. The cost of each workshop is $500 and participant numbers are limited.

The Symposium also includes a special session of papers related to the Catchment Modelling Toolkit.

For more details about registering for the Symposium or the workshops visit http://www.hwrs2003.org.au

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect - October 2003

At a glance - a summary of this article

The CRC is organising a Catchment Modelling School in Melbourne during 9-20 February 2004 comprising a series of targeted training workshops. The School is designed to assist professionals in the natural resource management sector to improve their hydrologic and related modelling skills. So that the CRC can provide the specific workshops of greatest value to the land and water management industry, we are asking for your expressions of interest by the website at www.toolkit.net.au/school.

The Catchment Modelling School

The CRC is committed to building and enhancing the hydrologic and related modelling skills within Australia's land and water management industry. Rob Vertessy in the Director's Note on the first page of this issue of *Catchword* has explained why and how this objective relates to achieving our mission.

At this key stage of our training program, the CRC is organising a Catchment Modelling School in Melbourne during 9-20 February 2004, comprising a series of targeted training workshops. We will be offering a wide range of modelling software-based workshops and general seminars for participants during the two weeks of the School. The length of workshops will vary from half a day to three days depending on the content and objectives. Seminars will run for one to two hours. The venue will be The University of Melbourne Parkville campus just north of the Melbourne CBD.

Tailoring the School to meet participant's needs

In planning for the School, the CRC has approached a wide range of respected presenters from within the CRC and outside. The support from people around Australia has been very strong and the list of possible workshops now totals over 30. So that we can target the School program as closely as possible to the needs of land and water managers and modellers, we have decided to ask for expressions of interest from interested participants. This will enable us to better plan for the more popular courses and schedule them for as many participants as we can.

In order to give *Catchword* readers a feel of what the Catchment Modelling School might offer, here are some examples of workshops that could form part of the School:

Model Development and Support

- Model Development Using The Invisible Modelling Environment - TIME (two days)
- Model Development Using The Interactive Component Modelling System - ICMS (two days)
- Detecting trend and other changes in hydrological data (one day)
- Model Calibration and Predictive Uncertainty Analysis using PEST (three days)

Climate Variability

- Stochastic data generation models (one day)
- Seasonal forecasting models (one day)

River Restoration and Engineering

- Environmental Flow Methodologies and the River Analysis Package - RAP (one day)
- Using the Hydraulic Analysis Module of the River Analysis Package (one day)
- Using the Time Series Analysis Module of the River Analysis Package (one day)
- Bed Stabilisation and Stream Crossing Design (one day)

Water Balance and Rainfall-runoff Modelling

- Rainfall-runoff modelling using RRL (the Rainfall-Runoff modelling Library) (two days)
- SIMHYD - A simple conceptual daily rainfall-runoff model (one day)
- WAVES - An integrated energy and water balance model (two and a half days)

Urban Stormwater

- Conceptual modelling of innovative urban water servicing approaches (two days)
- Rainwater Tank and Wastewater Reuse Modelling - Key Elements in Water Cycle Analysis and Sustainable Development (two days)
- Stormwater quality modelling using MUSIC (v. 2.0.0) (two days)
- Advanced stormwater quality modelling using MUSIC (one day)

Water Allocation

- The Application of Experimental Economics: 'State of the Art' economic policy evaluation workshop. (half day)

- Using the Water Reallocation Model (WRAM) with IQQM (half day)

Water Quality Modelling

- SedNet - Sediment and Nutrient Budgets for River Networks (two-three days)
- An introduction to the Environmental Management Support System (EMSS) (one day)

Please register your interest now

As you can see, it makes sense to ask participants for their preferences before we confirm a timetable. If you are interested in finding out more about the School and the details of workshops that can be offered, please visit the Catchment Modelling Toolkit website www.toolkit.net.au/school. If you would like to attend one or more of the workshops or are interested in obtaining further information, please nominate those workshops and register your interest and contact details on-line before Friday 7 November 2003. Naturally preference for popular workshops will be given to those participants who register their interest early.

With this information, we will be able to schedule the more popular workshops during the fortnight to best meet participants' needs. In mid-November 2003, the CRC will send you a 'proposal' providing details of the workshops you have expressed interest in and their dates. Participants will then be able to confirm or amend their selection of workshops using the proposal as the basis of registration for the School.

Other details

So that the School will be accessible to as many participants as possible, we have worked to keep costs down. Most of the workshops will cost between $330 and $440 per day and many will include a copy of the relevant software (and supporting documentation) so that participants can apply their new skills back in the workplace. In at least one case (the MUSIC model) there will be a modest charge for software. The workshop cost will include morning and afternoon teas and lunches.

Accommodation and evening meals are not included. Dinners with colleagues can be held in the Lygon Street precinct where a wide range of cuisines and atmosphere can be found. Participants from outside Melbourne can find a range of accommodation suggestions and contact details at www.toolkit.net.au/school

Complementary series of short industry seminars

To complement the user-focussed modelling workshops, the CRC will also present a series of short seminars or briefings on key related issues involved in catchment modelling. These short industry seminars will assist managers and other senior staff whose range of responsibilities include catchment management and modelling.

Focussing on broader industry and management issues, principles and practices, the short seminars will be scheduled during early morning and late afternoon sessions. There will be no charge for participating in these industry short seminars.

Examples of suggested presentations include:

- Trends in Catchment Modelling,
- Managing Modelling Contracts
- Integrated Catchment Management Philosophy.

A timetable of these short industry seminars will be available at the School web page during January 2004.

Further information

Personally I am very excited at the prospect of bringing together a broad spectrum of Australia's catchment modelling community as presenters and participants. The School offers a unique opportunity for training and information transfer, as well as an occasion to develop and renew links with colleagues throughout the land and water management industry.

For further information or to include your suggestions please contact me by phone or email.

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CATCHMENT MODELLING SCHOOL 9-20 February 2004

The CRC for Catchment Hydrology is proposing to hold a Catchment Modelling School during 9-20 February 2004 in Melbourne, Victoria.

The workshops-based School aims to equip participants with the skills required to undertake and interpret a range of modelling activities relevant to catchment management. Individual workshops based around the latest modelling principles, practices and products will be held during the two-week School and will vary in length from a few hours up to three days.

Please assist us in planning for the School by registering your interest before 7 November 2003

The CRC for Catchment Hydrology needs to know which workshops you would like to attend or are interested in. We will use this information to schedule the Catchment Modelling School timetable to suit as many participants as possible. Please visit www.toolkit.net.au/school for more details.

NOTE: Preferences for popular workshops will be given to those who have registered their interest before Friday 7 November 2003

www.toolkit.net.au/school

OTHER OUTLETS FOR CRC PUBLICATIONS

In addition to the Centre Office, all CRC publications are available through the Australian Water Association (AWA) Bookshop in Sydney and the Department of Sustainability and Environment (DSE) Resource Centre in Melbourne. AWA and DSE also stock a wide range of other environmental publications.

AWA Bookshop (virtual)
contact Diane Wiesner
Bookshop Manager
tel: 02 9413 1288
fax: 02 9413 1047
email: bookshop@awa.asn.au
web: www.awa.asn.au/bookshop/

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

POSTGRADUATES AND THEIR PROJECTS

Daniel Borg

BUREAU OF METEOROLOGY
VICTORIAN REGIONAL OFFICE
Flood Warning Summary
The following warnings are current:
lood Watch for North East Victoria
[Upper Murray, Mitta Mitta, Kiewa, Ovens and King Catchments]
Issued at 3:04pm on Tuesday the 30th of September 2003
Rain will develop during Wednesday afternoon and continue through Thursday, as a Result of a low pressure system moving from South Australia into Victoria. Rainfall totals of 20-40mm are likely in Northeast Victorian catchment areas.

As I write this postgraduate profile, a low pressure system is moving through the catchments of northeast Victoria. The Bureau of Meteorology has issued a Flood Watch for the region of Victoria that my study catchment falls under. I am particularly concerned with the rainfalls in the Granite Creeks catchment of the Strathbogies. Will there be the 40mm of rain that the Bureau of Meteorology predicts? Will the rain fall in the right areas? Will it be enough?

The better part of yesterday was spent installing monitoring equipment in the Granite Creeks with Dom Blackham (another CRC for Catchment Hydrology postgraduate researcher) in the hope that the forecast low pressure system will deliver sufficiently large flow events of interest in my study catchment.

One aspect of my postgraduate study involves investigating an alternative real-time pressure-based method of monitoring streambed elevation, particularly applicable to the monitoring of changes that are associated with instream large woody debris.

Large woody debris itself and its influence on geomorphic and hydraulic complexity can be important for both the structure and function of stream ecosystems. Removal of instream woody debris and the degradation of riparian zones (both considered as threatening processes under the Victorian Government's Flora and Fauna Guarantee Act, 1988) has lead to a general reduction in the instream geomorphic and hydraulic heterogeneity, resulting in a degradation of ecological integrity.

Reinstatement of large woody debris is a potential mechanism for restoring this abiotic complexity, particularly in sand bed streams. My work continues on from the large woody debris reinstatement trials of the CRC's 1999-2002 round of River Restoration Projects including Project 6.3: 'Restoration ecology in the Granite Creeks, Victoria', and Project 6.6: 'Developing tools to predict scour of rehabilitation works'. The research now sits in Project 6.12 (6B): 'Predicting spatial and temporal variations in channel form'.

Currently, deterministic predictive models of scour around instream structures suffer from a number of limitations when applied to ecologically relevant situations. Outcomes of Project 6.3: 'Restoration ecology in the Granite Creeks, Victoria', have revealed that the scour around reinstated large woody debris depends entirely on the flow regime. In other words, not only is the magnitude of a given flow event important in determining scour depth, but so also is the duration of that event and the frequency of subsequent events). Also, the variability between scour pool geometry and persistence for the same reinstated large woody debris design has been much greater than anticipated. So the CRC for Catchment Hydrology projects have identified that the geomorphic response of the streambed to large woody debris in real time is important, and a stochastic approach is required for ecologically relevant outcomes (as opposed to a deterministic approach which fails to capture the observed variability). Real-time monitoring of stream bed elevation is a way forward in addressing these knowledge gaps.

Traditional real-time bridge pier scour monitoring techniques cannot adequately be used to monitor stream bed elevation in our study streams. Relatively high debris loads and formation of debris dams around reinstated large woody debris structures precludes the use of traditional real-time monitoring methods. The pressure-based monitoring method I am investigating overcomes these limitations and will potentially be useful in addressing the knowledge gaps, modelling and monitoring issues of the persistence of scour pools associated with large woody debris.

Equipment has already been installed in the Granite Creeks, with further implementation scheduled for the coming months in the Lower Snowy River as part of the Snowy River Rehabilitation Trial.

I look forward to presenting some results soon!

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CRC PROFILE

Our CRC Profile for October is:

Denis Hussey

I am one of three independent directors on the Governing Board of the CRC. More significantly, however, as a resource economist and policy analyst I am part of a very small minority group (expertise-wise, that is) on the Board.

I spent the first half of my career in the Commonwealth public service, first in the then Bureau of Agricultural Economics (now ABARE), and then in the Department of Primary Industry (now AFFA). After a decade in the Bureau I moved in 1980 from the position of Deputy Director to take on the role of Head of the Policy Development Division in the Department.

Maybe I am naturally attracted to minority groups because during these years of public service there seemed to be plenty of opposition when trying to convince governments to interfere less in our lives and businesses, and focus more on improving policies and making better use of markets. If this group is still a minority then it is at least now a much bigger minority.

My interest in research and advocacy in pursuit of better public policy in resource industries, and possibly a view that I might achieve more if I was outside the 'government tent', led to me joining the ACIL Australia consultancy in late 1983. David Trebeck, then Deputy Director of the National Farmers Federation, and I established an ACIL office in Canberra.

One of my early assignments after this move was really the start of what is now my close association with the CRC for Catchment Hydrology. Colleagues in ACIL's Melbourne office included me in a team which undertook research for the Victorian Department of Water Resources into transferable water entitlements (TWEs). The research may not have been theoretically sophisticated but I think it was probably some of the first practical work in Australia into the development of water markets.

I remember to this day the pleasure of having as the client two water engineers who appreciated the importance and value of well functioning markets. The two people in question were John Langford, now (among other roles) the CRC for Catchment Hydrology's Independent Chair, and Don Blackmore, now the Chief Executive of the MDBC.

Note, however, that this work was done in 1983. Regardless of the discipline, all researchers know that ensuring worthwhile research findings are adopted requires determination and patience. While we have come a long way since then, there remains much yet to be achieved in terms of better natural resource policies and the scientific knowledge needed to underpin them. I am a strong supporter of the CRC for Catchment Hydrology because of its critically important role in contributing this scientific knowledge, which I consider it does extremely well.

Over the years following 1983 I was involved in many consulting projects which involved economic and policy research and advice in regard to natural resources. My first formal contact with the CRC for Catchment Hydrology was in mid-1998 when ACIL was approached to undertake a review of the Business Plan for a renewed CRC in the 1998 CRC selection round.

The first CRC for Catchment Hydrology was established in 1992 and in its fifth year review in late 1997 was judged "an outstanding CRC". As you might expect, therefore, we concluded that the rebid Business Plan was in pretty good shape although we were able to offer some suggestions for improvement. The next contact was in early 1999 when I was asked to participate as a panel member for a 'dry run' presentation by the bid team. Rarely do you have the opportunity to put such senior and well reputed people through the wringer. I only hope they enjoyed it as much as I did.

It was no surprise, and a reflection of the quality of work and attention to detail that typifies this CRC, that the rebid was successful.

Then came the 'phone call in mid-1999 asking me to put my money where my mouth was - would I accept an invitation to be an independent director. I was very pleased to accept the invitation and am enjoying the role immensely.

Since joining the CRC I have moved on from business ownership and full time consulting, and now spend more time on my farm (70kms north of Canberra) as well as occasionally facilitating meetings for established clients. Earlier this year I also took on the job of chairing the Living Murray's Social and Economic Reference Panel for the MDBC.

A recent highlight of my CRC for Catchment Hydrology involvement was being able to spend two days at the researchers' annual workshop (the annual 'love-in') at Yanco earlier this year. What an impressive group of professionals, with the bonus being they are a lot of fun to socialise with.

I have recently been reappointed for a second term and I am currently a member of the Rebid Strategy Group as we set about securing funding for a third CRC for Catchment Hydrology. While not being complacent (very dangerous), this CRC's impressive track record does provide us with excellent foundations on which to build a rebid for CRC for Catchment Hydrology 3.

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NATIONAL CONFERENCE ON INTEGRATED CATCHMENT MANAGEMENT (ICaM - 2003)

26-27 November 2003
Parramatta, NSW

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

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

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

COOPERATIVE RESEARCH CENTRE FOR
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OUR MISSION

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

OUR RESEARCH

To achieve our mission the CRC has six multi-disciplinary research programs:

- Predicting catchment behaviour
- Land-use impacts on rivers
- Sustainable water allocation
- Urban stormwater quality
- Climate variability
- River restoration

CRC AUSTRALIA

The Cooperative Research Centre for Catchment Hydrology is a cooperative venture formed under the Commonwealth CRC Program between:

Brisbane City Council
Bureau of Meteorology
CSIRO Land and Water
Department of Infrastructure, Planning and Natural Resources
Department of Sustainability and Environment, Vic
Goulburn-Murray Water
Griffith University
Melbourne Water
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Research Affiliates:
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Industry Affiliates:
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