NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 136 APRIL 2005

A NOTE FROM THE DIRECTOR

Rodger Grayson

Inside...

2005 CATCHMENT MODELLING SCHOOL

Modelling and the application of quantitative analysis tools are becoming a more and more common component of land and water management. This is driven by a variety of initiatives ranging from the high level, broad scale of the National Water Initiative and COAG reforms where a strong science basis is pursued, to the more local needs of catchment managers who have to set priorities in an efficient and defensible manner. More sophisticated approaches to target setting and performance evaluation are increasingly using software tools to enhance the value of limited data, and scenario modelling is now common place in assisting with decisions on alternative management actions.

Despite this clear trend to an increased use of modelling, and the considerable investment in modelling by groups such as our CRC and other organisations, the opportunities for learning about modelling and models are surprisingly limited.

Australian university undergraduate programs still have few offerings in this regard, and the situation is only slowly improving. Postgraduate opportunities tend to be limited largely to specialist applications in PhD programs. The scarcity of training opportunities is all the more significant when we consider that in modelling exercises, the skills and experience of the person doing the modelling are generally more important than the quality of the model! In addition, for the best use to be made of modelling outcomes, we need "smart purchasers" of modelling expertise.

Clearly our CRC is focussing on "delivering capability" through the provision of tools including models, but we are well aware that merely building tools is only the first step of true delivery of capability - models and other tools must be in the hands of industry and be actively used to assist in decision making.

To meet this need, in June and July this year we are presenting an unrivalled opportunity to learn about and use some of the new generation of catchment management tools. The 2005 Catchment Modelling School (CMS) will be held this year in two locations - in Sydney from Thursday 30 June to Friday 8 July 2005 and in Brisbane from Thursday 14 to Friday 22 July 2005.

The two schools are a fantastic opportunity to bring together a large proportion of Australia's broad modelling community - model users, developers of models and those who commission modelling activity or need to interpret the output from modelling exercises. There will be more than 30 different workshops of one to three days duration (to be repeated in each city), specifically tailored to the needs of industry and run by some of the country's most experienced modellers. There will be a wide range of workshops from sessions on major industry models such as MUSIC, IQQM, HEC-RAS and SedNet, to introductory and advanced sessions on our new integrated modelling platform E2. More general sessions aimed at a broader audience such as those who fund modelling activity or wish to use models to assist in policy development will also be offered. All sessions will involve "hands-on" experience with software, excellent supporting material and provide a forum for sharing experiences and learning from each other.

Last year a major group of participants was from the consulting industry (30%) with agency and catchment management staff accounting for 23%, staff from water utilities 16%, and students and researchers 20%. The balance of those attending were from community or related organisations.. We are looking forward having to a similar lively mix at the Catchment Modelling School this year so networking opportunities will be terrific. There will also be excellent scope for those at the school to broaden and deepen their knowledge of what is available and to find out how it will assist in their work.

Modelling will play an important role in the future of Australia's land and water management. Taking the mystery out of modelling and providing a very clear understanding of what can and cannot be achieved with models are critical for realising the potential of what is a relatively new activity. For some there is still a notion of modelling as a "back-room" exercise with opaque assumptions, undertaken by faceless technicians. But the opposite must be the case for modelling to be effective and contribute to better decision making. The responsibility for opening up modelling rests with all of us involved - from the developers and users, through to "smart purchasers".

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CRC PUBLICATIONS LIST

For a complete list of all available CRC publications please visit www.catchment.crc.org.au/catchword

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The 2005 Catchment Modelling School is all about making modelling more accessible and visible. It will build a wider understanding and intelligent use of catchment management tools - tools that I firmly believe will help take land and water management in this country to a new level.

For our CRC, this year's Catchment Modelling Schools are the cornerstone of our work to deliver catchment prediction capability to resource managers. I urge all of you to have a look at what is on offer (www.toolkit.net.au/school) and encourage you and your staff to participate in this exciting opportunity.

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leaders
GEOFF PODGER
& ROB ARGENT

Report by Robert Argent and Geoff Podger

Irrigation demand and supply in E2

Development of version 1.0.0 of E2, the whole-of-catchment modelling software, has focussed on essential catchment processes through functional unit (FU), sub-catchment, node and link operation. The current release of the E2 software supports development of a broad range of catchment model types, from long-term, static contaminant loads based on land export rates, to dynamic daily estimation of runoff and contaminant flows. The loads can be generated, filtered, transported and routed through catchment networks with tens to hundreds of sub-catchments.

One of the features being developed for the next E2 release is irrigation demand and supply modelling. The base for this feature is the irrigation and drainage module being developed within Project 2.19 (2A) "Reducing the impacts of irrigation and drainage on river water salinity". This module will provide the essential information on water demand through a water ordering process that takes account of the crop water needs, soil moisture status, and water flow 'travel time' between the irrigation area and the storage from which water is to be released.

Water Ordering

To establish an irrigation demand, the Project 2A irrigation module is associated with an E2 FU. Water orders are generated through an estimation of crop water needs (Figure 1.1).

In this figure, plant available water is reduced from field capacity to wilting point over a number of days, depending on crop evapotranspiration and precipitation. A water order volume is calculated based on the predicted water requirement some time in the future, equal to or more than the travel time. Orders are acted upon using "travel time" ahead, so if your irrigation area is three days flow time below the dam, and you order water to arrive three days from now, then your order will be acted upon today.

Each irrigator also has an "over-order factor" - an amount by which the soil water deficit is scaled to account for on-farm losses and other changes between dam release and application. This typically varies from one day (ie no over-order) for near-dam orders, to maybe two or more for many days travel time.

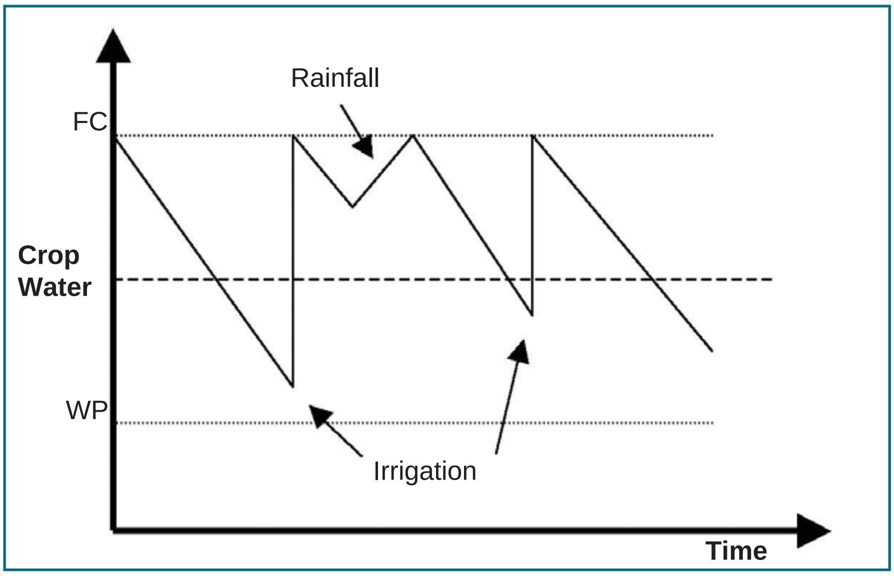

Figure 1.1

Water Order Accumulation in E2

In a catchment model within E2 there may be a number of irrigation FUs positioned in a number of sub-catchments, each of which has an identified water supply storage and a particular travel time. In E2, a water demand accumulator 'walks' up the supply network node by node, from bottom to top, adding up demand for a given time step, based on outstanding orders, and accounting for transmission losses and un-regulated inflows.

The simpler systems have single reservoirs or reservoirs in parallel, where water release is not affected by another storage downstream. For more complex systems, where there are multiple reservoirs on a reach, a process of passing water requirements from downstream to upstream storages will need to be developed.

Accumulated demands are then compared with the amount of water that is available in the various storages to determine the amount of water that is available to the farm. The resultant water volume is released, timed to arrive at the required extraction point at the right time in the future. If less than the ordered amount of water is available, the irrigation module is instructed to extract less water from the river, and this water is then applied across the crop demand and accounted for in the crop water demand assessment. Return drainage flows from the irrigation area are also estimated and passed back into the E2 flow system.

The Project 2A irrigation demand module uses a daily timestep, so the above description is based on daily considerations. For less complex models, such as with monthly demands, the issue of travel time generally becomes simplified with all or less of the water requirement being delivered within the same timestep that it is ordered, and the amount applied to the crop being subsequently altered to suit. Extraction of water by an irrigation FU is also constrained by physical or legal restrictions, such as pump capacity and water licence allowance. Licensing is handled by providing a total allowable extraction at some point defined to be the start of the water year. There are a range of factors that can influence this volume, and a number of manual options and simple rules will be developed to reflect this.

Other E2 Developments

As outlined last month, integration of the irrigation and drainage modules into E2 is just one of a number of enhancements and features that are being developed. The next release of E2 is planned to be available at the Catchment Modelling School, being held in Brisbane and Sydney, in July 2005.

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2005 CATCHMENT MODELLING SCHOOL

BRISBANE
30 June - 8 July 2005
at Griffith University

SYDNEY
14 - 22 July 2005
at the University of Sydney

The 2005 Catchment Modelling School represents a unique opportunity to understand and apply a new generation of software tools designed to underpin improved catchment management.

The School offers over 30 hands-on modelling software workshops delivered by some of Australia's best catchment modellers.

The 2005 Catchment Modelling School targets all professionals in the hydrologic and natural resource management community.

Places are filling quickly in many workshops. For further information and to register visit http://www.toolkit.net.au/school

NEW TECHNICAL REPORT

Erosion in Forests: Proceedings of the Forest Erosion Workshop - March 2004

by

Jacky Croke
Ingrid Takken
Simon Mockler

Technical Report 04/10

The material in this report is the product of a three-day workshop on Erosion in Forests held in Canberra during March 2004, the third in a series of documented workshops over the last ten years.

The aim of this workshop was to draw together participants in forest research, management and environmental conservation to discuss scientific findings, implications and key issues for sustainable management. This was achieved through formal presentations, field-group discussions and experimental demonstrations.

The collection of papers in this volume represents a collection of research in the major areas of forest management and incorporates the diverse range of forest management themes including water quantity, quality, fire management and sustainability that are taking place in forest research presently.

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

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au /publications

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER WALLBRINK

Report by Mark Littleboy

Evaluation and Application of the 2C Model

Background

This article presents a brief summary of results for the trial application of the 2C salt model developed in Project 2.21 (2C): "Predicting salt movement in catchments". Not all sub-catchments being modelled are within CRC for Catchment Hydrology focus catchments. Since the 2C project is two-thirds funded by the Murray-Darling Basin Commission, the model is being evaluated across a wider geographical extent than originally envisaged.

The original aim was to apply the 2C model in one or more high priority sub-catchments within the three CRC for Catchment Hydrology focus catchments. Instead, the 2C model is being applied across nine high priority sub-catchments, all within the Murray-Darling Basin.

Sub-catchments discussed

An evaluation of the 2C model for three of the nine sub-catchments is summarised here. The three sub-catchments are:

- Hodgson Creek: a 566km^2 sub-catchment of the Condamine near Toowoomba
- Kyeamba Creek: a 530km^2 sub-catchment of the Murrumbidgee, near Wagga Wagga.
- Bet Bet Creek, a 635km^2 sub-catchment in Central Victoria.

The other six sub-catchments are Tarcutta, Jugiong, and Bell in New South Wales and Wild Duck, Hamilton and Gardiner in Victoria.

Model operation

The 2C model quantifies surface and groundwater contributions of salt to catchment scale salt export, and predicts the impacts of land-use change on water and salt movement at a catchment scale. The key prerequisite of the 2C model is that its data requirements must be compatible with existing sources of data across the Murray-Darling Basin. 2C combines the best aspects of existing salt balance modelling within CSIRO and the three Industry Parties (Victoria DPI/DSE, NSW DIPNR and Queensland DNRM) to build a single model that will provide consistent and comparable results across the Murray-Darling Basin.

Spatial data used

The compilation of spatial data used for the evaluation and application of the 2C model included:

1. Land-use mapping, including detailed parameters to determine plant water use for each land use type.
2. Digital Elevation Models, for topographical analyses.
3. Soils mapping, including soil hydraulic properties for each soil type.
4. Climatic zones, derived from ANUCLIM climate surfaces. Daily weather data from SILO were used for each climate zone.
5. Groundwater flow systems mapping, including attributes for groundwater salinity, hydraulic conductivity, specific yield, aquifer depth and depth to water table.

Hydrologic processes

The hydrology of 2C is driven by the recharge "data cubes" modelling undertaken within Industry Parties. This process was described in a previous *Catchword* (October 2004). In summary, the data cubes contain monthly time series of surface runoff, subsurface lateral flow, recharge and evapotranspiration for every soil, climate and land use combination in a catchment. The data cubes represent the best available modelling for partitioning the rainfall into its various components.

The 2C model estimates stream flow by summing surface runoff and subsurface lateral flow from the data cubes with the groundwater signal from either hillslope discharge to stream, or alluvial area discharge to stream. As such, the surface runoff components of the predicted stream hydrograph are fixed by the data cubes and not calibrated in any way. The hydrological parameters in the 2C model only adjust the groundwater signal, specifically the recharge-discharge response.

Determining model parameter values

The parameters determining the groundwater discharge signal were obtained from a number of procedures. In Queensland, these parameters are manually adjusted until the model reflects the pattern of the base flow component of the stream hydrograph. In New South Wales, we are determining groundwater discharge parameters for one catchment and applying regionalised parameters for all other evaluation catchments. In Victoria, an optimisation approach is being used for each catchment. The results of these different procedures will guide future application of the 2C model when it is rolled out for all upland areas of the Murray-Darling Basin. For example, will regionalised parameters be sufficient for this rollout or will a full

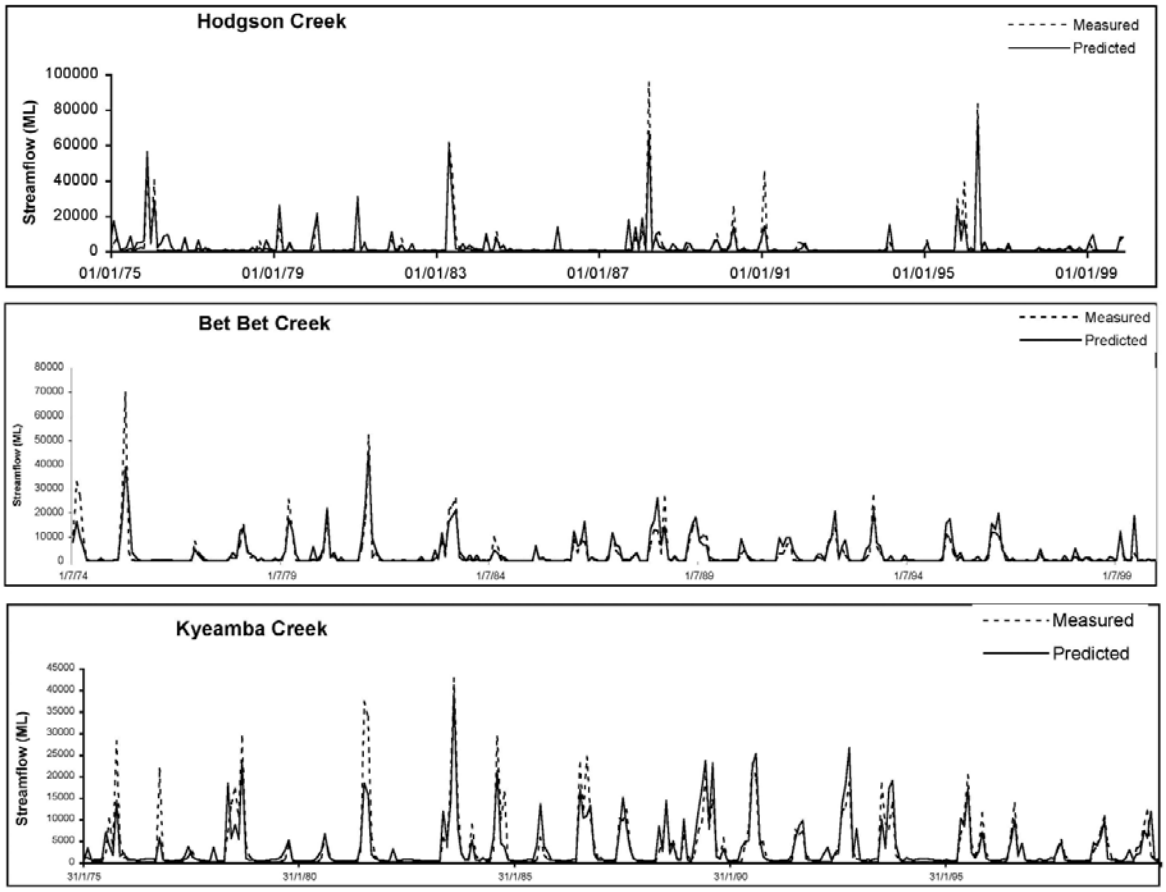

Figure 2.1: Comparison of predicted and measured stream flow for Bet Bet, Kyeamba and Hodgson Creeks

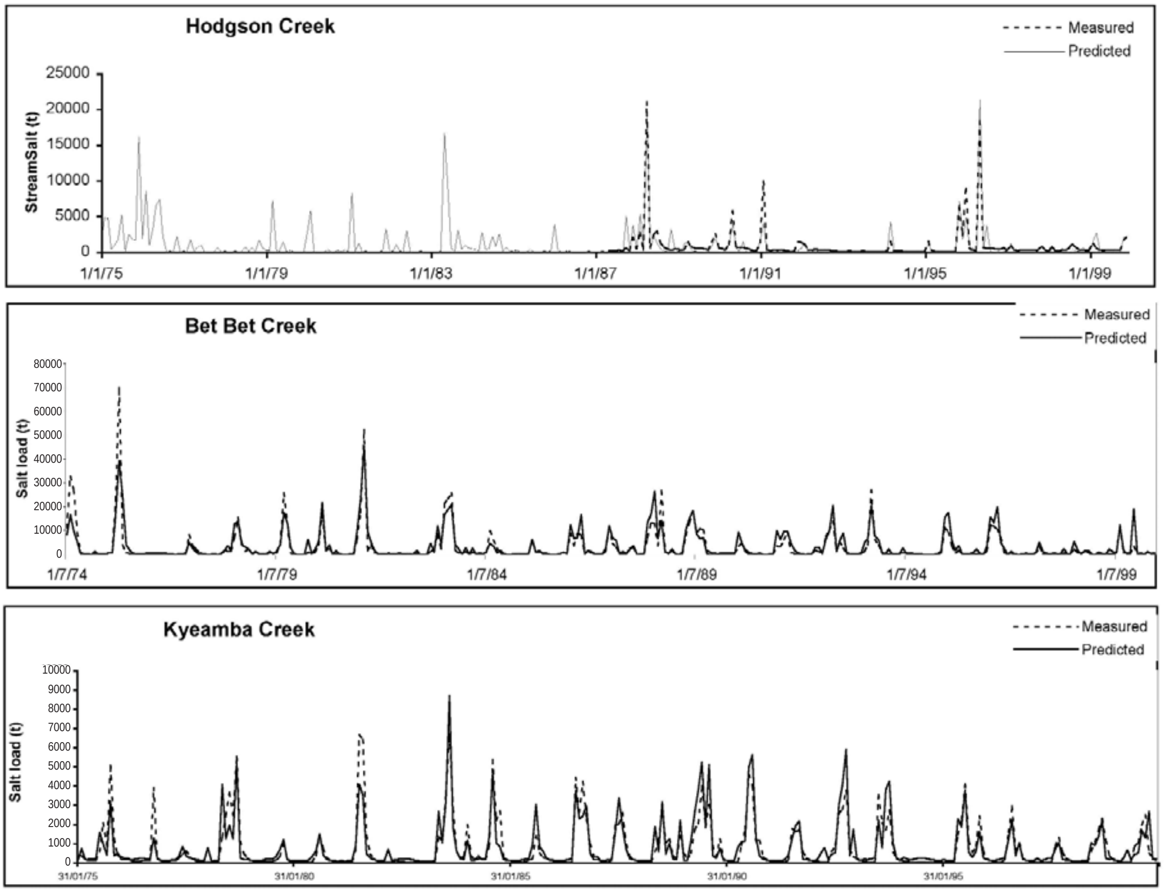

Figure 2.2: Comparison of predicted and measured stream salt load for Bet Bet, Kyeamba and Hodgson Creeks

NEW TECHNICAL REPORT

CLASS – Catchment Scale Multiple Land-use Atmosphere Soil Water and Solute Transport Model

by

Narendra Kumar Tuteja
Jai Vaze
Brian Murphy
Geoffrey Beale

Technical Report 04/12

CLASS is a distributed, eco-hydrological modelling framework that deals with water and solute movement from hillslope to catchment scale. This report describes the modelling framework, CLASS, which is at the more complex end of the modelling spectrum, but where there has been a major effort made to exploit the ever-increasing range of available data for setting up and running the model.

Three CLASS products are now available through the Catchment Modelling Toolkit at www.toolkit.net.au/class

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

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au /publications

SERIES ON MODEL CHOICE

The Model Choice series is designed to assist you to better understand catchment modelling and model selection. The first publication entitled 'General approaches to modelling and practical issues of model choice' is enclosed with this month's edition of *Catchword*

The second in the series entitled 'Water quality models – sediment and nutrients", is now available for downloading from the Catchment Modelling Toolkit web site at http://www.toolkit.net.au/modelchoice

Additional printed copies can be obtained by contacting Virginia Verrelli at the Centre Office.

A comparison of predicted and measured stream flow for the three sub-catchments considered in this article is presented in Figure 2.1.

Comparison of measured and estimated flow and salt loads

For all catchments, the agreement between measured and estimated stream flow is excellent given that the surface runoff components of the predicted hydrographs are uncalibrated. As described earlier, the calibration focusses on the groundwater response and hence the base flow component of these hydrographs.

For salt, mixing between groundwater salt stores is required. Currently, mixing coefficients are being calibrated for every catchment. It is hoped that regionalised mixing coefficients can be derived for the future rollout of the 2C model across the Murray-Darling Basin. A comparison of predicted and measured stream salt load for the three sub-catchments is presented below. For each of the three sub-catchments, the similarity between measured and predicted salt loads is excellent.

Reports underway

The results presented in this article are an overview only. Detailed reports are being finalised for the Queensland, New South Wales and Victorian Catchments. These reports are due to be submitted to the Murray-Darling Basin Commission in June 2005, as part of the 2C model accreditation process under Schedule C of the Basin Salinity Management Strategy.

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PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Marnie Griffith

Simulating farmer irrigation water management under uncertainty

Background

The aim of my project: 'Simulating farmer irrigation water management under uncertainly' is to develop a modelling framework which allows the simulation of how farmers respond to the uncertainty inherent in irrigation. This article presents an overview of the economic component of this modelling. The research originated in association with CRC Project 3.1: Integration of Water Balance, Climatic and Economic Models.

Study area

The area under study is the Goulburn system in northern Victoria (the irrigation areas fed predominantly by Lake Eildon). This area overlaps one of the CRC for Catchment Hydrology focus catchments, the Goulburn-Broken. The Goulburn system is divided geographically into major irrigation nodes, and then further into three irrigation industries (dairy, horticulture and mixed cropping and grazing) and six crop types (annual and perennial pastures, horticulture, lucerne, and winter and summer grain crops).

Economic modelling - uncertainty in decision making

For economists like me, questions about decision making under uncertainty are interesting in and of themselves. From the point of view of the CRC for Catchment Hydrology, the idea was to use economic modelling to enhance the capabilities of the water allocation models already in use, in this case the REALM model of the Goulburn System (the GSM). Other projects within the Sustainable Water Allocation Program have already incorporated water trading into water allocation models (for descriptions of this work see Program 3 articles in Issues 127 and 133 of *Catchword*). The modelling done in this research adds to the previous work by considering how imperfect information, uncertainty, and farmer attitudes to these aspects, impact on irrigation water management.

Farmer attitudes

Horticulture and mixed farmers aim to maximise total returns to their land and water, while dairy farmers aim to minimise the costs of feeding their cows (as this is a short run model, the number of cows is assumed to be constant). The variables they control towards these goals are: amounts of water allocated to irrigate crops, temporary water sales/purchases, and for the dairy industry, purchases of feed grain to replace pastures.

Farmers are subject to various price and production uncertainties. This project focusses on uncertainty linked to hydroclimatic variability, which feeds through to three parameters: water allocations; seasonal crop water demands, and temporary water market prices.

Irrigators' decisions

To summarise the irrigators' problem, they are asked to decide how much water they plan to allocate to irrigating various crops (and how much supplementary feed to buy for dairy) and how much water they plan to buy/sell, without knowing the following:

- how much water they will have available over the whole season (allocations)
- how much water they will need, or even how valuable this water will be in irrigation (crop water requirements)
- the opportunity cost of using water in irrigation rather than selling it (temporary water market prices).

Sometimes there may be no real cost to this uncertainty in that farmers can correct their plans as more information becomes available; other times, they may have already lost the opportunity to carry out what is later known to be optimal.

Simulating decision making

In this project, farmer decision making is simulated via a discrete stochastic program (DSP). This technique is an extension of linear programming devised to deal with multistage problems 'where (any number of) the functional, restraint, and input-output coefficients are subject to discrete probability distributions' (Cocks 1968).

The irrigation year is divided into three seasons: spring, summer and autumn. Each season can be either wet or dry. The crop water requirements for a wet versus a dry season are based on simulations of REALM/PRIDE over 110 years of historical climate data.

Initial allocations (drawn from the same REALM simulations) are made at the beginning of spring, prior to any decisions being made. Each initial allocation is associated with a high, versus a low, updated final allocation. At present, the modelling assumes that this final update occurs at the beginning of summer. This is to keep the model size more manageable given that allocation updates in the last two-thirds of the season only happen about 17% of the time in practice. Future work may see allocation updates made in both summer and autumn.

NEW TOOLKIT PRODUCTS

Over the last couple of weeks a number of new Catchment Modelling Toolkit products have been released including:

IHACRES - a catchment-scale rainfall-streamflow modelling methodology whose purpose is to characterise the dynamic relationship between rainfall and streamflow, using rainfall and temperature (or potential evaporation) data, and to predict streamflow
www.toolkit.net.au/ihacres

E2 - a software product for whole-of-catchment modelling. It is designed to allow modellers and researchers to construct models by selecting and linking component models from a range of available choices. E2 enables a flexible modelling approach, allowing the attributes and detail of the model to vary in accordance with modelling objectives
www.toolkit.net.au/e2

AQUACYCLE - a daily urban water balance model which has been developed to simulate the total urban water cycle as an integrated whole and provide a tool for investigating the use of locally generated stormwater and wastewater as a substitute for imported water alongside water use efficiency
www.toolkit.net.au/aquacycle

For further information about the Catchment Modelling Toolkit visit www.toolkit.net.au

Expected temporary water market prices vary with allocations and seasonal conditions. Actual temporary water market prices are formed when farmers enter the water market.

Decision making through the year

Figure 3.1 shows the decision making process through the year.

Water market initial simulation

The first discrete stochastic program for each season is a preliminary plan for that season and the rest of the year. The solution for desired water sales/purchases from these discrete stochastic programs forms the basis for water market activity. The water market is run in exactly the same way as Watermove (the water exchange set up by Goulburn-Murray to facilitate trade): the maximum amount of water is traded at a common pool price such that buyers pay at most what they bid and sellers receive at least what they bid.

Plans versus actual irrigation needs

The results from the water markets, combined with the actual irrigation needs for the current season, are then given to farmers. A second discrete stochastic program for the season is run. Whereas the first discrete stochastic program gives a plan for the current season (and future seasons), the second discrete stochastic program is what actually happens (and a revised plan for future seasons). A file is run to update the land and water constraints as inputs for the following season.

Resolving uncertainty

In all, the modelling involves running the six discrete stochastic programs for each industry in each node and three water markets. Each discrete stochastic program becomes a smaller problem as time moves forward and some uncertainty is resolved.

A number of scenarios will be developed involving information about and attitudes to uncertainty. The model will be re-run, and sensitivity in farmer's decisions to the different assumptions noted.

Current challenge

The current challenge is to integrate this framework with REALM. At the moment, REALM simulations are an input to the economic modelling described above, but there is no feedback in the other direction. There are two problems associated with this: firstly, there is no reality check on whether desired water can actually be delivered; secondly, there is no scope for the results from the economic modelling to feed back into future allocations, which may well be significant. With the assistance of REALM modelling experts from the water industry, I hope to meet this challenge over the next few months.

Reference

Cocks, K. D. 1968. Discrete stochastic programming. Management Science 15:72-79.

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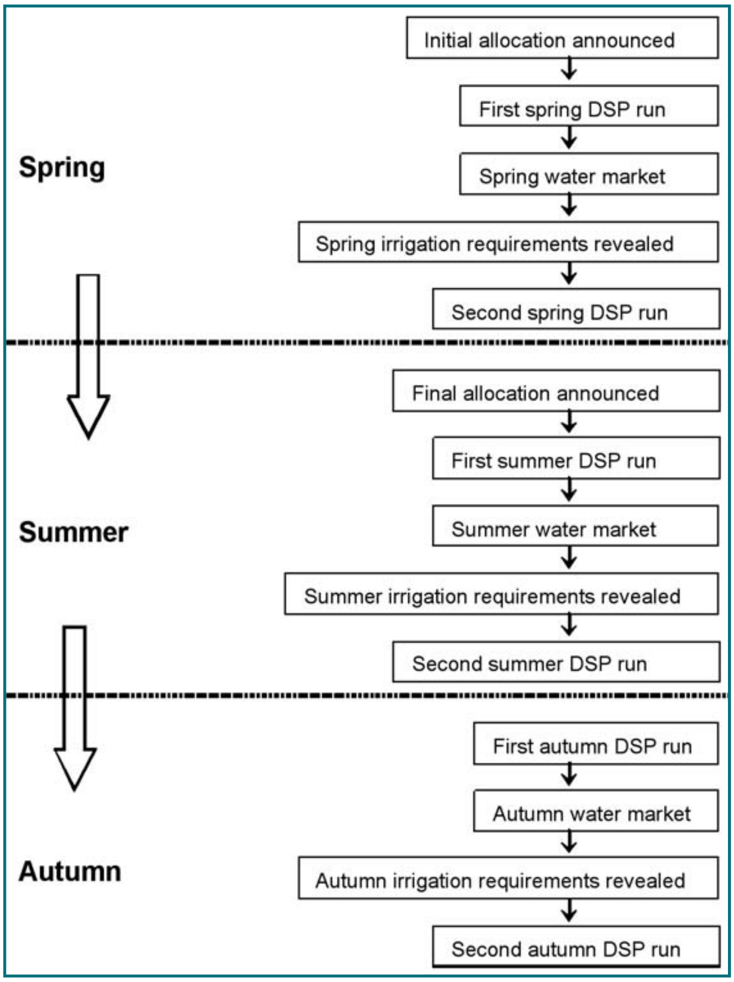

Figure 3.1 Modelling of irrigators' decision making process under uncertainty

TOOLKIT SOFTWARE

WRAM

WRAM is a software application to simulate water allocation and trading between irrigation areas.

The Water Reallocation Model (WRAM) is a Windows application to simulate water allocation and trading between irrigation areas. Based on an economic optimisation model, WRAM can be integrated with hydrologic network models for assessing water resources management plans.

In addition, WRAM performs standard input-output analysis, and integrates input-output accounts in value terms with water accounts in physical units to assess the impact of water reallocation on regional economy.

You can find out more about WRAM and download the software from the WRAM web site: http://www.toolkit.net.au/wram

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Tim Fletcher

MUSIC update: versions 2.1 and 3.0

This month I'd like to update you on recent work on MUSIC (Model for Urban Stormwater Improvement Conceptualisation) by the Program 4 Team. Specifically, there are two activities I wish to describe:

- Updating MUSIC version 2, to deal with an error in the bioretention filter-media algorithms for nitrogen and phosphorus, and to improve the precision of the storage-discharge relationship governing hydrologic routing in treatment storages
- Enhancements and new features to be incorporated into MUSIC v3, due for release in May 2005.

Updated bioretention and storage-discharge algorithms: release of MUSIC v2.1

All MUSIC users will be aware (through extensive communications by the CRC) that the MUSIC Development Team discovered an error in the way MUSIC v2 predicted nitrogen and phosphorus removal in the filter media (see Figure 4.1) of bioretention systems. This resulted from a programming error in two lines of code, where the coefficients of the TSS removal equation were incorrectly coded into the TP and TN removal equations also. The result was that MUSIC v2 could over-predict the effectiveness of biofilters in TP and TN removal.

However, whilst this error was very easy to fix, the MUSIC Development Team took the opportunity to update these algorithms to incorporate the latest national and international research, including laboratory and field studies from our own research (at both Griffith University and Monash University). More information is available at the MUSIC website (www.toolkit.net.au/music), and in Appendix D of the MUSIC User Manual.

Bioretention systems remain an effective stormwater treatment device, and MUSIC simulations reflect this. There is ongoing research within Griffith and Monash University, and we hope to be able to improve the current design of biofilters to improve their performance further in the future (for example, by incorporating filter media layers targeting specific pollutants, and by enhancing denitrification). Such enhancements will be incorporated into future versions of MUSIC, under the direction of the new eWater CRC.

The follow up of many in industry to the MUSIC bioretention error was a concern about the size of the bioretention system. A common question was simply "how much bigger do I have to build the bioretention system to satisfy the required water quality standard". However, the issue can be tackled in a broader way. Examining Figure 4.1, it is apparent that there are many factors which can be manipulated to achieve the desired water quality outcome. For example, choosing a smaller filter particle size will increase treatment, and increase detention time (because of the correspondingly lower hydraulic conductivity), but may increase the proportion of flow which spills over the overflow weir. A designer's challenge is to find the most robust, cost-effective combination of parameters which meets or exceeds water quality targets.

MUSIC v2.1 also includes increased precision in the storage-discharge relationship which governs outlets from stormwater treatments. The increased precision will result in more accurate water quality performance prediction. The cost, however, is increased computation time in situations where there is a very small outlet to a large storage. Users will thus be 'warned' by MUSIC where they are proposing to simulate 'ridiculously' small outlets.

NEW MUSIC SOFTWARE - VERSION 2.1

MUSIC Version 2.1 is now available for downloading from the Catchment Modelling Toolkit website at http://www.toolkit.net.au /music

We recommend all registered MUSIC users log in as a Toolkit member, download the Version 2.1 MUSIC software installer and release notes, run the installer file and enter their user registration code to access the Version 2.1 software.

MUSIC Version 2.1 corrects an error in the algorithms that predicted Total Phosphorus (TP) and Total Nitrogen (TN) removal through the filter medium of a bioretention system. It also corrects an occasional error with flow mass-balance calculations in treatment systems, which occurred under unusual circumstances (usually when outlet sizes were very small).

Further details about the impact of this error are available in the release notes on the download page.

Visit www.toolkit.net.au/music

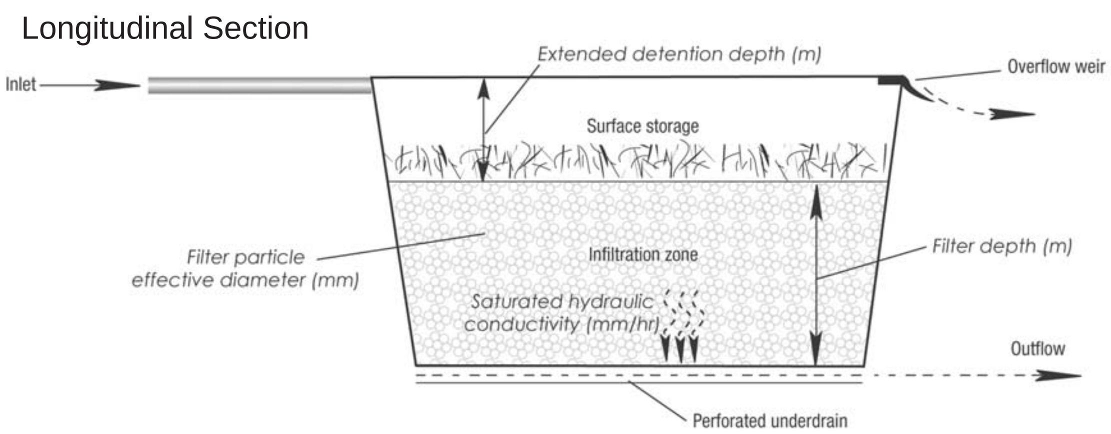

Figure 4.1. Conceptual representation of bioretention system (source: MUSIC User Manual), showing some of the parameters of the system that can be altered by the designer (other parameters include the ponded surface area, filter surface area, and presence of a low-flow or high-flow bypass).

FRESHWATER ECOLOGY REPORT

Urban Stormwater and the Ecology of Streams

By

Chris Walsh
Alex Leonard
Tony Ladson
Tim Fletcher

Technical Report 05/4

This CRC for Freshwater Ecology Technical Report explains why urban stormwater degrades the ecological condition of urban streams, during dry, rainy and very wet conditions, but most importantly following just a little rain.

It shows how a new approach based on reducing the effective imperviousness of an urban catchment, using water sensitive urban design (WSUD) can lessen the damaging effect of urban stormwater. WSUD is a general name for a suite of measures now being used by stormwater managers and planners to intercept and treat urban water. WSUD can be applied at a range of scales, ranging from source to 'end-of-pipe'.

Bound copies are available from the CRC for Freshwater Ecology or an Adobe pdf file can be downloaded from www.catchment.crc.org.au/publications

New features in MUSIC v3

The current focus of the MUSIC Development Team is the release of MUSIC Version 3. This version of MUSIC incorporates a number of important changes, some small, some major, to enhance the capability of MUSIC. For example, version 3 includes:

1. A Lifecycle Costing module, which allows the lifecycle cost of a single treatment, or an entire treatment train, to be predicted. The module is based on the lifecycle costing Associated/Additional Project led by André Taylor. Stormwater managers from around Australia were surveyed to determine costs associated with the design, construction, operation, maintenance, renewal and decommissioning of a wide range of stormwater treatment measures. An example of the Lifecycle Costing output is shown in Figure 4.2.
2. Two new treatment nodes: infiltration system and rainwater tank. Whilst these two systems could previously be simulated with the bioretention node and pond node respectively, in MUSIC v2, the advent of Lifecycle Costing means that separate nodes for these devices are required (since they have different lifecycle costing elements to ponds and bioretention systems)
3. A new point-source node, which allows you to import a time-series of flow and water quality (concentrations), to act as a source-node. This node will also prove very useful in calibrating treatment performance of MUSIC (because an observed inflow time-series will be able to be imported, from which observed treatment can be calibrated).
4. There is the option to locate the perforated drainage pipe within a bioretention system at any height within the filter media. This allows designs where deliberate "loss-infiltration" strategies are used, such that a bioretention system collection pipe only operates once the filter media trench fills to above its invert. In situations where infiltration losses are desired (and there is no risk to adjacent infrastructure), this is an important potential strategy.
5. Export files can now be created at a range of timestep, regardless of the timestep at which the model was run (obviously you cannot export simulation results at a smaller timestep than the simulation!).
6. Increased precision is allowed on a number of user-inputs, such as re-use specification, to allow smaller-scale simulations.
7. A number of minor, occasional bugs have been fixed.
8. A review of calibration defaults for k and C* has been conducted for a number of stormwater treatment measures, and the new defaults will be incorporated.
9. MUSIC can now export files directly for use in the CRC's flexible catchment-scale modelling system, E2.

MUSIC v3. can read v2. files, but v3. files cannot be read in v2 (v3. includes extra time-series that v2. is not capable of reading).

The MUSIC Team is currently working on testing of version 3 (and writing the new User Manual), with planned release for May 2005.

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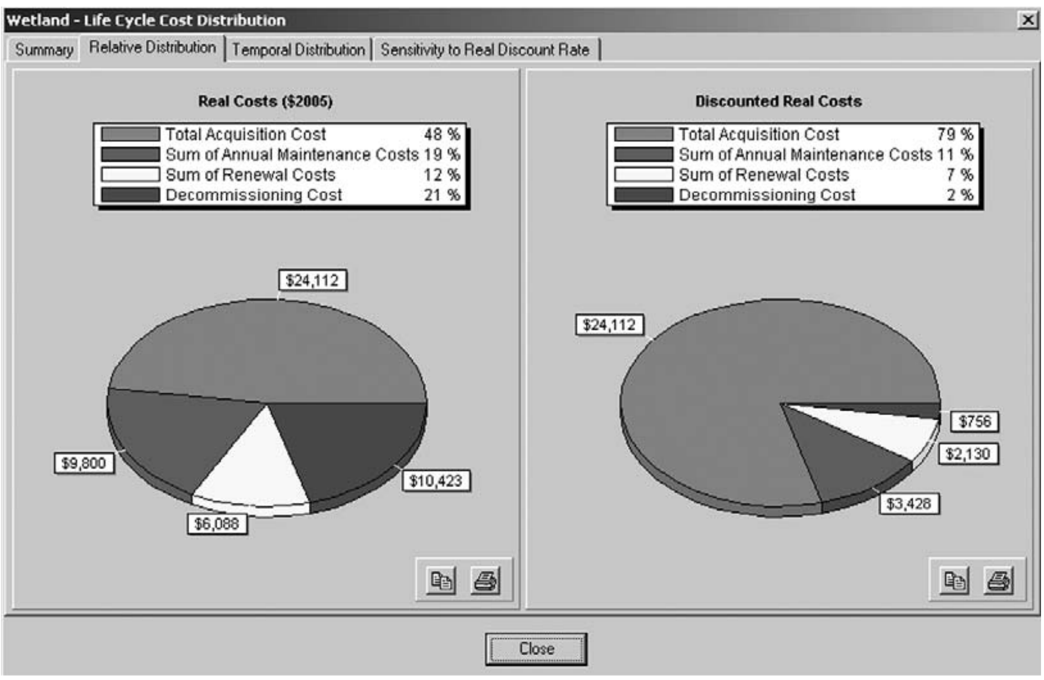

Figure 4.2. Example (draft only) output of the MUSIC v3. Lifecycle Cost module.

PROGRAM 5

CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Andrew Western and Senlin Zhou

How well does the VB95 landsurface model simulate runoff?

Background

The Bureau of Meteorology routinely runs weather forecasting simulations for Australia and the surrounding seas twice a day. These simulations include a hydrological and surface energy balance model that is run on a grid resolution of 0.125º of latitude and longitude. This model, referred to here as VB95 - Viterbo and Beljaars (1995), is based on the European Centre for Medium Range Forecasting land surface scheme. It provides estimates of runoff, soil moisture and evapotranspiration, along with all the surface energy balance terms. This article describes results of testing of the model runoff predictions for ungauged catchments in the Murrumbidgee River Basin.

The VB95 model

Models such as VB95 have been developed with a focus on land-atmosphere exchanges of water and energy as required in simulations of weather and climate in atmospheric models. While runoff is predicted, it is not generally used operationally and typically receives little emphasis in the modelling effort. However, because such models are routinely run by weather agencies around the world, they provide comprehensive simulations of hydrologic response at spatial scales down to about 100km2. These simulations provide a real-time estimate of the hydrologic state of our landscapes along with current and forecast runoff, but with limits on accuracy. With appropriate improvements to the modelling, such a product could potentially be provided by weather agencies and would find many beneficial uses, provided the quality was sufficient.

Water balance in model

The water balance in VB95 is based on a four-layer solution of the moisture-based form of Richards' Equation. Throughfall from the canopy infiltrates and is subject to bare soil evaporation and transpiration before draining from the 2.89m deep soil profile under a unit hydraulic gradient. This drainage forms the bulk of the simulated runoff and represents a slow response runoff path. Infiltration excess runoff is simulated on occasion and a second quick runoff source occurs where a layer (typically the top 7cm layer) becomes oversaturated during heavy rainfall and the excess water is allocated to runoff.

Evapotranspiration in the model is simulated using a detailed representation of the surface energy balance and is split into canopy evaporation, bare-soil evaporation and transpiration. Transpiration is drawn from the top three soil layers (top 1m) directly. Since the majority of simulated runoff is from drainage out from the bottom of the soil, rather than from surface runoff processes (that provide no opportunity for transpiration), the evapotranspiration in combination with the rainfall is the key control on water balance.

Setting model parameters

In this study the parameters of VB95 have been set using the parameters from the Bureau of Meteorology's implementation in their operational forecasting models. The model uses a single soil type, which is represented as a typical medium textured soil with a nominal plant available water holding capacity of 250mm and saturated hydraulic conductivity of 16mm/h. The vegetation (fraction of cover) in the model is determined from a course temporally averaged data set and is about 0.85 for these catchments.

Model testing results

VB95 has been applied to 15 catchments (Figure 5.1) in the mid-upper Murrumbidgee for the period 1970 to 2004. In this section we look at the overall simulated water balance for the study period, the seasonal pattern of the water balance, the monthly runoff hydrograph and briefly examine some issues with daily runoff hydrographs.

Simulations have been run on a thirty-minute time step. Most atmospheric forcing data (air temperature, humidity, short and longwave radiation and wind speed) have been developed from a combination of Bureau of Meteorology data sets (Siriwardena *et al.*, 2003), while precipitation was estimated from the SILO daily rainfall grids and disaggregated to a 30-minute time step using temporal patterns from nearby pluviographs.

Long-term water balance

The fifteen catchments modelled in the Murrumbidgee represent a climatic gradient determined primarily by annual catchment average precipitation, which ranges from 650mm to nearly 1200 mm. The runoff coefficient is strongly determined by this gradient (Figure 5.2) and varies by a factor of six across the catchments. Annual runoff depth varies by a factor of ten. VB95 does a good job of simulating the long term water balance response to this climatic gradient, although there is a tendency to slightly overestimate runoff. This is more noticeable in the wetter catchments (6 of the 7 wettest catchments are overestimated).

The percentage errors in runoff coefficient are often quite large when one considers individual catchments, varying

NEW TOOLKIT DATA PRODUCT

Landcover Type for the Intensive Use Zone of Australia (LIZA)

The second Catchment Modelling Toolkit data product has been released on the Catchment Modelling Toolkit website.

The LIZA data cover the intensive use zone of Australia. They provide cover type estimates for 1990 and 1995, along with a first estimate of woody vegetation canopy cover percentage and canopy height. Data are available in both Geographic (on GDA94) and Map Grid of Australia coordinate systems. The spatial resolution is 0.01 degrees or 1km.

The data are derived from the Australian Land Cover Change project data sets (Bureau of Rural Sciences).

Further details and downloads are available at www.toolkit.net.au/liza

between -25% and +84% of the observed runoff. When one considers evapotranspiration rates inferred from catchment water balance considerations, VB95 generally predicts rates within 10% of the observations. These differences in relative accuracy reflect the small component that runoff consitutes in the water balance. Given that a uniform soil water storage capacity is assumed everywhere and that only crude information is available on vegetation, these results are not unexpected; however, significant improvements would be required to make them hydrologically useful.

Seasonal and monthly water balance

Figures 5.3 and 5.4 show the seasonal and monthly water balance for the Cotter River (1100mm/a rainfall) and Tarcutta Creek (800mm/a rainfall). The Cotter is one of the best modelled catchments, while Tarcutta Creek is more typical. Tarcutta Creek shows a good simulation of the monthly runoff, except for a delay of typically about 1 month in the timing of the main runoff response. This delay varies between catchments and tends to become more pronounced in the drier catchments.

The delay relates to the runoff processes embodied in the model. Very little runoff is produced by surface runoff pathways, thus the infiltration must percolate through about 3m of soil profile before becoming runoff. In reality, a much greater proportion of runoff is produced by processes characterised by fast flow paths, including subsurface stormflow and especially saturation excess and infiltration excess surface runoff. The unrealistic delay introduced by the dominant flow pathway assumed in the model is even more obvious at the daily timescale (not shown).

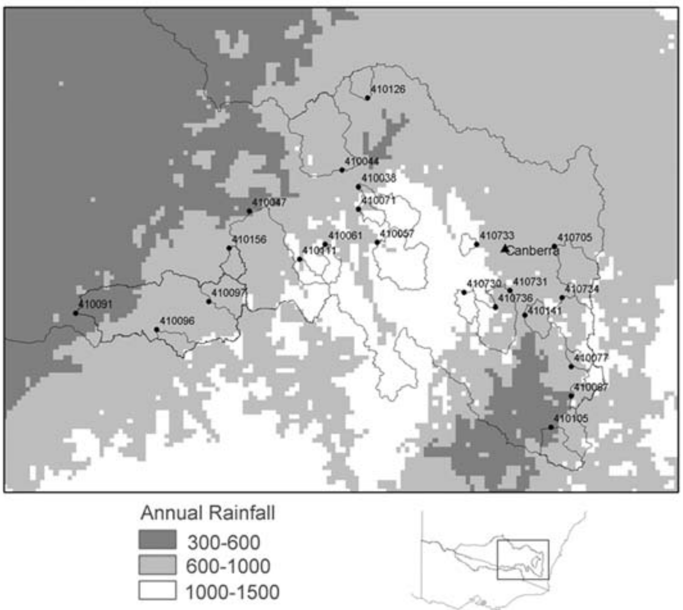

Figure 5.1: Gauged unregulated catchments in the mid- and upper-Murrumbidgee focus catchment.

Model Improvements

There are two challenges to improving the performance of VB95 (and other similarly structured models) from a hydrological perspective. The first relates to model structure and the importance of different flow paths (residence times) to the simulated runoff. VB95 needs to simulate more surface runoff and rapid subsurface runoff if it is to realistically represent landscape hydrology. In part, this means a recognition of spatial variability and its impact on soil water storage and runoff production at the sub-grid scale (noting that these models typically run on a grid scale of the order of 100km^2 or larger). It also means a recognition that the free-draining lower boundary condition assumption (with rate parameters typical of surface soils) needs modification. Both these issues are being addressed in model modifications we are testing at present.

The second area critical to model performance is the setting of parameter values to better represent landscape variability at scales resolved by the model grid. Previous work has focussed on this with respect to soil moisture prediction and the impact of soil property and vegetation assumptions (Richter *et al.*, 2004). A significant challenge in this area remains the derivation of accurate hydrologic parameters from maps of soil type, vegetation type and vegetation vigour.

References

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Siriwardena, L., Chiew, F., Richter, H. and Western, A., 2003. Preparation of a climate data set for the Murrumbidgee River Catchment for land surface modelling experiments. 03/1, Cooperative Research Centre for Catchment Hydrology, Clayton.

Viterbo, P. and Beljaars, A.C.M., 1995. An improved land surface parameterisation scheme in the ECMWF model and its validation. Journal of Climate, 8, 2716-2748.

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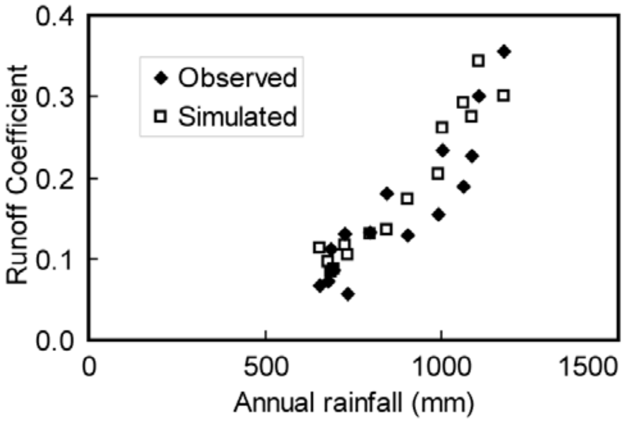

Figure 5.2: Simulated and observed runoff coefficients for 15 catchments in the mid to upper Murrumbidgee River Basin.

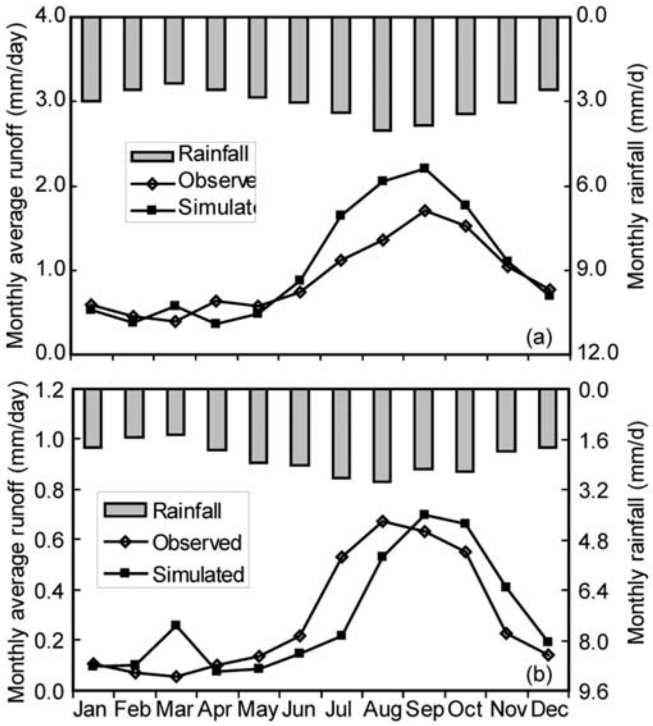

Figure 5.3: Simulated and observed seasonality in runoff for (a) the Cotter River (410730) and (b) Tarcutta Creek (410047). The seasonal rainfall distribution is also shown.

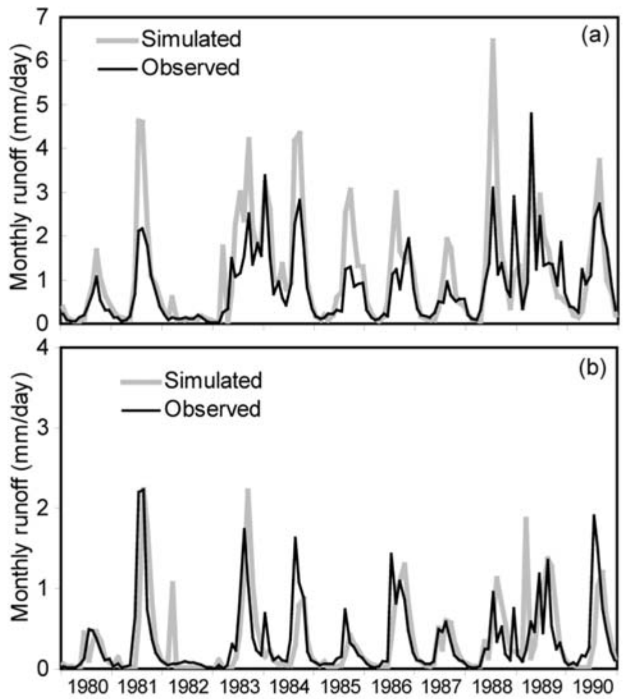

Figure 5.4: Simulated and observed monthly runoffs for (a) the Cotter River (410730) and (b) Tarcutta Creek (410047).

NEW TOOLKIT SOFTWARE

CatchmentSIM

CatchmentSIM is a freely available stand-alone 3D-GIS application specifically tailored to hydrology based applications. It can be thought of as a collection of topographic and hydrologic analysis algorithms that have been purpose built for the process of hydrologic analysis and included in a Windows based user-friendly GIS environment.

CatchmentSIM is designed for use by anyone interested in automated catchment delineation and parameterisation from GIS data. However, the software is primarily focused on automated setup of run-files for flood and stormwater hydrograph models.

For further information visit www.toolkit.net.au/catchmentsim

NEW TECHNICAL REPORT

Evaluating the Effectiveness of Habitat Reconstruction in Rivers

By
Michael Stewardson
Peter Cottingham
Ian Rutherfurd
Sabine Schreiber

Technical Report 04/11

River restoration is a new science and many projects are necessarily experimental. Our understanding of processes of degradation is improving but our ability to prescribe efficient restoration treatments which might include environmental flows, reintroduction of large wood debris and riparian restoration is still limited.

This report reviews approaches to river restoration. Those considering an evaluation will benefit from reading the limitations and advantages of the various approaches. River engineers, aquatic ecologists and fluvial geomorphologists now work in multi-disciplinary teams to plan river restoration work including monitoring and evaluation. In recognition of this, two chapters of this report are devoted to discussing conceptual aspects of restoration planning and evaluation as common ground across the disciplines.

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

This report is also available as an Adobe Acrobat file from www.catchment.crc.org.au/publications

PROGRAM 6
RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Mike Stewardson, Ron DeRose and Ciaran Harman

Modelling Channel Dimensions throughout River Networks

Impact of river cross-sections on catchments

The size and shape of river cross-sections affect many catchment management issues. Cross-section geometry influences the delivery of flow, sediment and nutrients through catchments. Through its effect on in-channel flow conditions, channel shape determines the range of hydraulic habitats available. Through its controls on channel flow capacity, channel size has a major influence on the frequency and duration of flooding. Because of the importance of the channel cross-section in catchment management, models of channel form have been developed as part of the CRC for Catchment Hydrology catchment modelling capability.

Empirical models

In Project 6.12 (6B): 'Predicting spatial and temporal variations in channel form', we have developed empirical models to predict channel cross-section dimensions and bankfull discharge from regional datasets, normally available across Australia. A range of different parameters were considered for predicting cross-section form including catchment relief, sediment load, flow statistics, river planform, and riparian vegetation.

- Channel width

  Using available channel data and a regression analysis, we found that the channel width could be estimated using the 1.5 year recurrence interval flood magnitude ($Q_{1.5}$) in m^3/s and the meander wavelength (λ) in metres:

  channel width = $1.75(Q_{1.5})^{0.36}(\lambda)^{0.20}$ $\quad r^2 = 0.77^2$

- Channel depth

  Channel depth could be estimated using 1.5 year recurrence interval flood magnitude ($Q_{1.5}$) and the extent of annabranching (N = number of channels drawn on the 1:25,000 topographic maps)

  channel depth = $1.47(Q_{1.5})^{0.39}(e)^{-0.095N}$ $\quad r^2 = 0.71$

- Bankfull discharge

  Bankfull discharge could be estimated using the 1.5 year recurrence interval flood magnitude ($Q_{1.5}$), the meander wavelength (λ) and channel slope (s)

  bankfull discharge = $0.74(Q_{1.5})^{0.93}(\lambda)^{0.34}(s)^{0.24}$

  $r^2 = 0.70$

Data used and its applicability elsewhere

These regression equations were developed using channel dimensions estimated for 114 river reaches in Victoria. These rivers span a broad range of climates and river types, so are likely to be applicable in other parts of Australia. However this should be verified using channel data from other regions.

Unexplained variance and other factors

The equations explain between 70% and 77% of the variance in channel dimensions and bankfull discharge (natural log transformed). This still leaves a substantial amount of variation (23% to 30%) unexplained. Some of this unexplained variance will be the result of errors in estimating the variables in the regression equations. However, much is likely to be the result of factors not considered in our analysis, in particular bank sediment strength and stabilizing affects of bank vegetation.

Regulated versus pre-regulated floods

We wondered if it would be better to use the 1.5 year flood for the regulated flow regime (rather than the estimated pre-regulation flood magnitude). Adjustments of channel size to river regulation are well documented in a few cases. If channels have mostly adjusted to the effects of regulation, than the regulated flood magnitude should provide a better estimate of the channel dimensions.

We tried this, but found it didn't work as well as the unregulated flood magnitude. In fact, the regression equation also included a parameter characterising the degree of regulation (the ratio of the regulated to unregulated flood magnitude) which effectively rescaled the regulated flood magnitude to a value close to the unregulated flood magnitude.

This indicates that river regulation has not had a consistent widespread effect on channel dimensions and bankfull discharge in South East Australia. However, this doesn't rule out local or widespread but variable effects of river regulation on channel form.

Estimating unregulated floods

In cases where the flow was regulated, we estimated the unregulated flood magnitude (Q1.5) using hydrological regionalisation. We also have equations that use mean daily flow or catchment area instead of the 1.5 year flood magnitude, for situations where the flood magnitude isn't known. These models aren't quite as good (i.e. they have larger errors) but may be useful for some applications.

Applications of empirical models

The empirical models developed in this study will be useful in catchment modelling applications where changes in channel form are not important. For example, modelling the effects of flow regulation on physical habitats in the absence of geomorphic changes, or flood and sediment routing in stable channels. It is unrealistic to expect this broad-scale empirical study to provide highly accurate models. In some cases, errors may be too large for models to be useful in applications. To establish appropriate confidence in model performance, error terms are available for the models. Anyone using these models can vary the error terms to evaluate the sensitivity of their results to model uncertainties.

Other river reach parameters

In addition to bankfull width and depth, we have also developed models for estimating a range of hydraulic geometry parameters for river reaches. These parameters proved more difficult to model using the available regional datasets, probably because of the dependence on channel shape which is influenced by boundary sediment characteristics.

Technical report

We're currently preparing a CRC Technical Report describing this research. Work is on-going to relate the hydraulic parameters to instream physical habitat attributes. For more information contact Mike Stewardson at mjstew@unimelb.edu.au.

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COMMUNICATION & ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect - April 2005

At a glance - a summary of this article

The 2005 Catchment Modelling School is now open for registrations and based on the expressions of interest collected, places will fill quickly, particularly in the most popular workshops. If you or your colleagues would like to participate in the School in either Brisbane or Sydney during July please visit www.toolkit.net.au/school

Note: Credit card payments can be accepted on-line.

Catchment Modelling School - Expressions of Interest

Preparations for the Catchment Modelling Schools in Brisbane and Sydney during July 2005 are now in full swing. We received a very positive response through the website to our request for expressions of interest (EOIs) from potential participants with over 260 EOIs recorded. This has allowed us to review our range of possible workshops and schedule the most popular courses to meet participants' needs. Thank you to all those *Catchword* readers who visited the website and gave us their preferences.

The response from Brisbane participants was somewhat stronger than from Sydney, reflecting perhaps the locations of our Parties that make up the CRC for Catchment Hydrology. Nevertheless, the generally high level of interest from potential participants from New South Wales reassured us that we had made the right decision to hold the School in Sydney as well as Brisbane.

If you have colleagues in Sydney who you believe will be interested in some of the workshops that the School has on offer, we would appreciate it if you would let them know about the School and its website at www.toolkit.net.au/school

Registrations now open

By the time you read this edition of *Catchword*, the registration period for courses will have been open for a little under two weeks. The EOI process indicates that the most popular courses, for example, MUSIC, Introduction to Catchment Modelling, and Whole-of-Catchment Modelling using E2, will be filling fast. After years of research and software development, this is a

UPCOMING CONFERENCE

A Conference, entitled "Barmah-Millewa Forest: Indigenous Heritage, Ecological Challenge" is being organised by the Royal Society of Victoria, for 18-19 June 2005.

Full details of the conference are now available on the website of the Royal Society of Victoria at www.sciencevictoria.org.au

Go to the link "Barmah-Millewa Forest" for the program and the registration form.

8TH INTERNATIONAL RIVER SYMPOSIUM 2005

Water and Food Security – Rivers in a Global Context
6-9 September 2005, Brisbane

2005 Thiess Riverprize – Call for Nominations

Detailed information can be found at www.riverfestival.com.au /symposium

fantastic reward for the teams that have committed their time and resources.

Participating in the School - a range of benefits

There are many aspects to participating in the Catchment Modelling School. One of the key features of the Catchment Modelling School workshops is hands-on experience with the software. In addition to understanding the knowledge behind the software and its application, School participants have the opportunity to individually apply software and gain skills in using it to meet their needs. Further, the workshops are presented by research staff who are leaders in their research fields. This provides the opportunity for participants to query aspects of the underlying knowledge as well the execution of the software.

The experience of the first Catchment Modelling School in Melbourne during 2004 was also one of networking. The gathering of a wide group of professionals from many different organisations with a common interest in hydrologic modelling ensures that breaks for morning and afternoon tea and lunch are filled with conversations, introductions and some vigorous debates!

For the CRC, our definition of a product is more than just the software. Much of the work in providing a product through the Catchment Modelling Toolkit is the documentation and other resources designed to assist the user. This principle holds true for the Catchment Modelling School. All of the workshops are supported by user-focussed documentation. For most workshops this includes the software User Manual for the software, and copies of the relevant presentation slides. Many products also have tutorials and other supporting information to assist participants when they return to their workplace.

Learning about recent advances

With the increasing use of modelling across the land and water industry, keeping up with what tools are available is no simple task. The Catchment Modelling School is intended to make this easier and help broaden and deepen the capability of people throughout the industry. It targets all natural resource management sector professionals who wish to improve their hydrologic and related modelling skills, including staff in the hydrologic modelling community. Model users and those commissioning modelling studies are also included. The School also represents an opportunity for natural resource management students to develop their understanding and skills at the forefront of catchment management.

Registrations close 31 May

The Catchment Modelling School website at www.toolkit.net.au/school is now open for registrations and participants can select one or more workshops to meet their needs.

This year, payment can be made on-line through our secure transaction system, or alternatively, registrations forms can be faxed to the Centre Office and a tax invoice sent to the registrant or their nominated accounts department.

I hope that all *Catchword* readers consider the range of workshops being offered and select those that will assist them to better manage our natural resources.

For further information about the range of workshops scheduled during the School or to register please visit www.toolkit.net.au/school

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POSTGRADUATES AND THEIR PROJECTS

Nilmini Rukma Siriwardene

Sometimes I wonder why I'm doing this PhD. Certainly I didn't plan to do it. When I was a kid, I was told once that when you get into university, life becomes much fun (though I find it hard to believe now).

I was really good at mathematics in school and so I decided to do engineering. Soon after I finished my civil engineering degree, I found myself in a remote and dry zone of the countryside, working as a project engineer in an irrigation project in Sri Lanka. This was a new and exciting experience for me, as the project was to provide irrigation and social structure facilities to a huge jungle area. After three years of challenging work, I got married and moved to Bahrain, as my husband worked there. After two marvellous years, our son was born and we decided to return to Sri Lanka.

After staying home as a housewife for a while, I started working again, this time as a structural engineer in a government office in the city. At this point, I thought I would be working there until I retired, as it suited me in every way. Somehow this situation was changed in 1999 because my husband got a job offer in Australia. We came here only for a two year trial period, as it was not an easy decision to made, especially when we had to leave our family behind. I enjoyed the luxury of staying home for a while, but it was not long before I was itching to get back to work again. However, I struggled to find a job as a civil engineer in the city, as most employers were looking for people with local experience. So I decided to retrain and started doing a postgraduate diploma in IT at Swinburne University though I had no background in IT. While I was doing this diploma I received a scholarship to do a Master of Engineering by research at Victoria University. Suddenly, my life of luxury was over, but I took up the challenge to work in both universities and was able to finish both successfully.

Soon after I finished my research at Victoria University, the wonderful opportunity to work with Dr. Ana Deletic and Dr. Tim Fletcher came through Dr. Tony Ladson. I was told that the project topic was related to stormwater, which was similar to the area of my previous research, so I jumped at the opportunity to get involved in this project. This project at Monash University is associated with the CRC for Catchment Hydrology.

I started my project in March 2004. The main aim of the project is to develop a fundamental understanding of the clogging processes of stormwater infiltration systems, and based on this knowledge, to develop a new, reliable and robust model for sediment transport and clogging prediction.

An infiltration system is basically a hole in the ground filled with gravel. These systems help to bring back the pre-urban environment by artificially directing stormwater into the ground. Therefore infiltration practices are used as the preferred method to manage runoff on new development sites in several countries. However, the biggest threat to these systems is the possible failure of the system due to clogging. Therefore, it is necessary to develop a clogging prediction method to determine the life span of these systems to achieve cost effective results in future.

The first stage of my project is based on conducting one and two dimensional laboratory experiments (1D-Rig and 2D-Rig) experiments, to simulate the traditional infiltration system that consists of crushed stone overlaying soil. The 1D-Rig, which is constructed as a vertical column by using 20cm diameter mountable segments, will be used to understand sediment transport as a one dimensional flow. The 2D-Rig, which is 3mx2mx0.35m in size with mountable perspex panels, will be used to understand two dimensional flow regimes, as infiltration systems usually behave as 2D systems.

My first task was to set up the 1D and 2D rigs. It was not an easy task at the beginning, as so many problems were encountered, such as water leaking through the mountable segments/panels; the programs used to control the inflow to the rig did not work properly; pressure sensors attached to the rig started malfunctioning; water pumps failed; inflow tubes jammed with sediments and many more problems. I felt like it was never going to work! After fixing these problems and doing some trial runs, actual tests started with varying one variable at a time. These variables included stormwater levels through the crushed stone, inflow rates, groundwater levels and soil types. The stormwater for the tests was prepared by mixing tap water and sediments (i.e. less than 300µ) collected from the nearby pond. So far, I have been able to complete six experiments with the use of the 1D-Rig. The first 2D-Rig experiment is nearly completed. In general, each experiment was stopped when the outflow[TdF1] was reduced to 10% of the original flow, which happened within 3-4 weeks for the 1D-Rig. During these experiments, water samples were also collected from the crushed stone layer and from the inflow in order to analyse the total sediment concentration and particle

2005 CATCHMENT MODELLING SCHOOL

BRISBANE
30 June - 8 July 2005
at Griffith University

SYDNEY
14 - 22 July 2005
at the University of Sydney

The 2005 Catchment Modelling School represents a unique opportunity to understand and apply a new generation of software tools designed to underpin improved catchment management.

The School offers over 30 hands-on modelling software workshops delivered by some of Australia's best catchment modellers.

The 2005 Catchment Modelling School targets all professionals in the hydrologic and natural resource management community.

Places are filling quickly in many workshops. For further information and to register visit http://www.toolkit.net.au/school

size distribution. The segments/panels of the rig needed to be carefully dismantled when an experiment was finished, as the sediments trapped along the filter needed to be measured by weighing the stones of each segment/panel separately.

In all these experiments, I found very clearly that the hydraulic conductivity of the infiltration systems decreased with time due to clogging of the soil/stone interface. I also found that the infiltration system does not empty completely between wetting cycles; the sediment accumulates mainly around the minimum water level of the system. This may have important implications on the development of the clogging layer at the interface since this accumulated sediment of high density (that concentrates at some depth above the soil/stone interface) will act as a plug. This behaviour may affect the concentration and particle size distribution of the sediment moving towards the interface. However, the data set is too small for me to be able to draw any definite conclusions yet.

In the next stage of the project, I will focus on analysing and developing the sediment transport and clogging prediction model, once I have obtained a reasonable data set through laboratory experiments.

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CRC PROFILE

Our CRC Profile for April is:

Nick Murray

My professional life began the day my father gave me a beating for dismantling the calculator he'd given me for my ninth birthday. I just wanted to see how it worked. Several broken electronic components and a red backside later, I was none the wiser.

Thus I became interested in electronics, and was accepted into electrical engineering at Melbourne University in 1985. Upon discovering the vast amount of chemistry involved in the common first year, I dropped out a day later, and headed off to the Royal Melbourne Institute of Technology, where I studied Communications and Electronic Engineering for the next few years.

In my final year, 1989, I had a chance meeting with a recruitment officer from a Defence organisation (I was probably in the wrong interview room!), and landed a job as a graduate electronic engineer, working on communications and cryptographic equipment.

Several years later, I moved to Canberra with the same Defence organisation, though through a contract with Telstra at the time. My role was to further develop and test a cryptographic device and its software. After a series of contracts that were extended by months, then weeks, and finally days (!) at a time, I moved in 1995 to the Defence Logistics Support Group. It was here that I discovered that a large amount of Defence communications capability was based around some ancient 300MB disk drives that were the size of washing machines. You've never heard a disk crash (or smelled a disk crash) like a crash from one of these.

Much of my job at Logistics Support was writing software development standards, developing a standard user environment for networked computers, developing the odd software application and supporting a few of the Defence networks.

After spending way too many nights formatting old 300MB disk packs, in 2000 I headed for Sweden, where an Australian company, ERG, had an office. ERG produces ticketing systems hardware and software, and had a customer in the south of Denmark. So much of my time was spent in the air flying between Stockholm and Copenhagen, or occasionally Stockholm and Billund (near Legoland), followed by high-speed runs down the E45 motorway to the Danish customer's location in Aabenraa.

Aabenraa is a small town of around 20,000 people, divided not so much along racial lines as nightclub lines. If you're a certain age, there's a certain club you go to. Period. Though my boss did go to Sgt. Peppers Lonely Hearts Club (for the 16-18 year olds) a few times because of the cheap beer. So he said. My tasks in Denmark were testing and documentation of some ageing, though still functioning, bus ticket machines. These were due to be linked to a sophisticated GPS system that would enable patrons to see the exact location of each bus on a digital map of southern Denmark, located at major bus interchanges. The rationale was that patrons need to know when the next bus will arrive, lest they be standing for long periods of time at remote bus stops. Remote, in this context, means anywhere more than 10km from the nearest village. Occasionally, though, we would "lose" buses: we could not match their GPS IDs with other information needed to trace them. So, we would have to go and physically locate a bus, which led me to chasing a bus around the coast for an hour before I caught it at the depot.

Eventually, the system came together and passed all its tests, and I returned to Australia.

In early 2003 I began work at CSIRO Land and Water in Canberra. Much of my time has been with the CRC for Catchment Hydrology, where I've developed standards for the documentation and user interfaces of Catchment Modelling Toolkit products, and developed training materials for the TIME framework. I'm also currently developing a "utility" Toolkit product that automatically checks documentation styles and helps authors to get their user guides into the Toolkit format. As part of the Toolkit Strategy Group, I've also had some input into the information delivery aspects of the Catchment Modelling Toolkit. In fact, the most gratifying part of my job has been to help managers of the Toolkit products take their products and have them released to the world. The product development and delivery process, though sometimes quite busy, is hugely rewarding.

Outside of work, my interests include flute, Auslan (Australian Sign Language), teaching English as a second language, running and weight-training. One day I hope to do further studies in linguistics, possibly in the area of sign language phonology or semantics. This would mean a move to Sydney or Melbourne, which is problematic in that I'm quite fond of Canberra.

And it's just occurred to me that I never did get that calculator back together.

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WHERE ARE THEY NOW?

Report by Debbie Woods

I left Melbourne University in early 2004 to take up a position with the Department of Sustainability and Environment (DSE) as a Project Officer in the Water Allocation Group. Geographically, I didn't go very far, about 2 km down the road - from Carlton to East Melbourne. Like many others, I had not quite finished my thesis when I started working. After eight months of intense pressure with working and studying, I submitted my Master of Science thesis titled "Environmental Floods for Victorian Regulated Rivers" in August 2004. I am pleased to report that my thesis was examined, passed, and that I can now graduate.

My research focussed on the impact of dams on flooding patterns at 21 large dams across Victoria. I assessed whether those dams could release a flood for the environment based on the level of impact on floods and the infrastructure capacity of the dam outlet structures. I also looked at some of the critical success factors needed when planning an environmental flood release and some of the constraints to making environmental flood releases.

My work at DSE involves a wide range of activities. At the moment I am working on implementing projects from the Government's White Paper on Water, 'Our Water Our Future'. In particular I am managing the State Water Accounts project and the State Water Inventory project. These projects will report on the use and allocation of water across Victoria and compliance with entitlements to water, including surface water, groundwater and recycled water. Issues relating to the condition of the water resource and availability of Victoria's water, such as climate change and the impact of bushfires will be highlighted.

I am also involved in managing water resource and allocation issues arising from the current drought, such as water restrictions. I have gone from one hydrological extreme with my flood research to the other with drought management. Another key aspect of my role at DSE is overseeing compliance with bulk entitlements across the State, ensuring entitlement holders are 'doing the right thing'.

I would like to thank my supervisors Assoc Professor Ian Rutherfurd and Dr Michael Stewardson for their support over the past three years, as well as everyone involved in the CRC for Catchment Hydrology for making my research a rewarding and enjoyable experience. In addition I would like to thank the Department of Sustainability and Environment for its support while I was finalising my thesis.

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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
Grampians Wimmera Mallee Water Authority
Griffith University
Melbourne Water
Monash University
Murray-Darling Basin Commission
Natural Resources and Mines, Qld
Southern Rural Water
The University of Melbourne

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