NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

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A NOTE FROM THE DIRECTOR

Rodger Grayson

Inside...

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

COMMUNICATIONS AND ADOPTION REVIEW

There is no doubt that we are in a communications age. The flood of information that assaults us visually, audibly and in written form in our everyday lives is as astonishing as the lack of quality control! So for an organisation like our CRC, whose raison d'être is communication and adoption, a major challenge is ensuring that our messages can be heard amongst the noise. Without awareness by others of what we are doing, we cannot hope to achieve engagement. Without engagement, we will not achieve adoption.

Our initiating Business Plan was very clear about the importance of communication and adoption:

"The major performance indicator for the CRC for Catchment Hydrology will be the level of adoption of research outcomes."

There are many ways in which this can be measured, but, as with the approach taken to measure the quality of our research, independent assessment is one of the most important. In 2001 and again this year, we engaged consultants to review our communication and adoption performance via surveys of CRC stakeholders. This enabled some analysis of trends over a period where there has been significant change in emphasis of some of our activities. For example in 2001, the Catchment Modelling Toolkit was just an idea. Now it is a website (www.toolkit.net.au) where over 2000 members have performed over 5000 downloads of an increasing array of software and data. Our development projects were in their early stages in 2001 but are now in full swing with great examples of adoption at the coalface.

The 2004 survey was not only an opportunity to compare our current activities with those in 2001, but also a chance to look forward. This latest material will help us prepare for our own "final push" and assist in the development of communication and adoption plans for the eWater CRC bid. Of particular interest was determining the extent to which our research has already had an impact, and how this may change in the future.

The survey was undertaken by a company specialising in market research and communication, with wide experience in the commercial arena. We deliberately chose consultants not directly associated with natural resource management to both enhance independence, and provide an opportunity for us to learn from their broader experience. They surveyed three groups of stakeholders, using three different methods. Internal stakeholders (staff and students from CRC parties) had the opportunity to fill out self-completion questionnaires via email, with around 50% responding. External stakeholders (300 selected randomly from our mailing and contact lists) participated in a ten-minute telephone survey with some similar questions to the internal stakeholders. The third group was "key" stakeholders including Board members and senior executives from major land and water management organisations who participated in "in-depth" telephone interviews.

Over a third of participants were from private companies, with around a quarter from State government agencies, and around ten percent from local government or research organisations. Questions were based on those in 2001 and included the relevance of our research, application of outcomes, satisfaction with our communication activities, comparison with similar organisations, and the current and likely future impact of our research. These last two aspects were not addressed in 2001, but are particularly important. Not only do we want our products adopted, we want to be sure they are making a difference. There was also a separate series of questions for users of the Catchment Modelling Toolkit.

The overall results were extremely pleasing, indeed the company which conducted the survey commented that they have rarely been involved with such a positive set of results! In the Program 7 report in this issue of *Catchword*, David Perry delves into the detailed results, but here I will highlight some of the stand-out statistics from the external stakeholders.

Over 90% of external stakeholders considered that our research is relevant, and approximately 70% have applied CRC outputs themselves. Over 80% believe that the application of CRC outputs has had an impact, with half of these believing the impact was "major or strong". Over 80% are intending to use CRC outputs and virtually all are expecting some impact (65% expecting "major or strong" impact). Overall satisfaction with our communication activities was also very high (over 80%) and we are extremely well regarded when compared to similar organisations. The results from internal stakeholders indicate improvement over the very high base of 2001, with similar results from the key stakeholders.

CRC PUBLICATIONS LIST

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

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While these statistics are obviously terrific, there is always room for improvement, with suggestions including improved availability of information electronically, and more technical seminars and workshops. The importance of workshops and training was reinforced by all stakeholder groups and clearly seen as a primary vehicle for delivering on our mission.

As our research projects enter their final phase, the need for high quality, relevant and efficient communication is paramount. Our key stakeholders summarised the priorities during their interviews:

- Complete and communicate current research projects,
- Focus on developing the software tools; and
- Continue the provision of workshops as a key means of learning how to apply the CRC research.

Workshops will feature prominently over the next ten months. We are planning training as part of the Hydrology and Water Resources Symposium in February 2005, another Catchment Modelling School in mid 2005, specialist workshops for our Development Project teams later in the year, and a range of seminars and training workshops for particular software tools and the use of modelling in management. Of course our other communication channels such as *Catchword*, technical and industry reports, the CRC and Toolkit websites will continue, along with one of our most effective methods, personal contacts.

The success of our communication and adoption activities is a credit to everyone involved in our CRC. These results are a reflection of the outstanding teamwork and shared vision I see throughout our CRC, from informal chats over coffee to Board and Program Leaders' meetings. David Perry and his team are ably leading the communication and adoption charge, and his job is made much easier by the willingness and enthusiasm across all our research and development project teams and administrative support.

We look forward to continuing our current communication activities and improving our delivery even more to ensure those expectations about the impact of our research are realised.

Finally, I would like to thank all those who participated in the Communications Review, either by filling out the on-line survey or by telephone interview. It is great to get your feedback and your constructive suggestions will be particularly useful for our future communications planning.

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Report by Joel Raham with contributions by Shane Seaton and Jean-Michel Perraud

E2 – A nerd's eye view

E2 development

I rank as a newcomer to this whole E2 caper, having been distracted by various other products (SedNet, TREND) and projects over the recent months. Shane Seaton and Jean-Michel Perraud have been carrying the E2 coding-flag and now I've got the chance to peek inside at the inner workings of the system. As I come up to speed with the model I have decided to 'flesh out' some of Rob Argent's comments (*Catchwords* 130 and 127) with some additional details.

One of the first things that strikes you about E2 is the sheer breadth of capabilities being built into the model. E2 takes a lot of the lessons (good and bad) from a range of existing catchment models, including EMSS, SedNet and IQQM, and encapsulates them in a framework focussed on the interchangeability of modelling components. For example:

- EMSS and IQQM each provide one rainfall runoff model (SIMHYD and Sacramento, respectively), whereas E2 allows users to choose from any of the rainfall runoff models available in the Rainfall Runoff Library. In addition, advanced users can add a new rainfall runoff model to E2, if they find it is more appropriate to their study area.
- EMSS and SedNet both rely on automated terrain analysis routines to construct the river network for the model, whereas E2 provides the choice of using either terrain analysis or a 'Roll Your Own' approach which may involve importing and existing network or interactively 'drawing' one.

E2 also allows flexibility in the choice of routing models, reservoir models as well as the selection of pollutants that are simulated.

Building a software system with such a high degree of flexibility is an exciting task for software developers, but it is potentially very daunting! Like TIME, E2 is a framework within which specific models can be created. However, where TIME is a framework for environmental models within a fairly large domain, E2 is a specialisation of TIME that specifically supports catchment modelling using a river network.

Elements of the E2 Framework

- E2 nodes

E2 models are built around a node link representation of a river system. 'Nodes' represent individual sub-catchments, as well as other entities, such as gauging stations or point source inputs to the system. Nodes are connected via 'links', which represent the major channels in the system, or perhaps elements of a distribution network, such as an aqueduct between reservoirs.

An E2 node is the principal way in which water and pollutants enter the river network. Typically this will be runoff and pollutant export from a sub-catchment, represented as a series of 'Functional Units', or FUs (see *Catchword* 130). The FU approach gives users a good deal of flexibility to choose the most appropriate models, and to vary the level of detail by varying the number of distinct FUs that are represented.

A researcher is also able to define their own node types, allowing extensions such as a catchment node that uses a fully distributed, grid-based model. Thus E2 provides two levels of flexibility at the sub-catchment level: selecting (or developing) new component models within the FU conceptual framework, or developing a new sub-catchment representation (such as a grid based sub-catchment).

- E2 links

E2 Links are responsible for transporting water and pollutants through the river network, and include the ability to 'transform' the flow, such as dampening flood waves or depositing sediment in channel. A specific link contains various link models, which might include a Muskingum scheme for flow routing and a sediment transport capacity model for sediment deposition and transport. E2 links can be extended to support special types of links, such as reservoirs links. A researcher can define their own link model, covering a single aspect (such as water flow), or several (such as pollutants).

- Major applications

A major use of E2 is to model the movement of various pollutants around a catchment. Initially, these pollutants are Total Suspended Solids, Total Nitrogen, Total Phosphorous and Salt. The methods for modelling each of these vary, and it is quite likely that future users of E2 will wish to model other pollutants, such as E-Coli. For this reason, E2 has been designed to allow the rapid addition of new component pollutants. A pollutant (along with other quantities, such as Dissolved Oxygen) is modelled as a

NEW SOFTWARE VERSION

Rainfall Runoff Library (RRL)

Version 1.0 of the Rainfall Runoff Library software is now available from the Catchment Modelling Toolkit web site at www.toolkit.net.au

The user manual and software has been updated in response to feedback from users since the Catchment Modelling School in February 2004. This version replaces the earlier beta versions available through the Toolkit web site.

There is no cost to obtain the RRL software but you must be a registered member of the Catchment Modelling Toolkit.

For further information about the RRL update please visit www.toolkit.net.au/rrl

NEW TECHNICAL REPORT

Estimating Extractable Soil Moisture Content for Australian Soils

By

Tony Ladson
James Lander
Andrew Western
Rodger Grayson

Technical Report 04/3

This report uses an unconventional approach to estimating plant available water content for Australian soils. Instead of using laboratory measurements of soil properties, the authors have collected actual measurements of soil moisture from a wide range of field studies around Australia.

In total, extractable soil water capacity is presented for 180 locations that include the six States and two Territories. The report also compares estimates of extractable soil moisture from field measurements with those from the Atlas of Australian Soils.

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

Constituent. Each application of E2 can have a different number of constituents based on the data availability and problem definition for a study area. Each constituent is generated by a contaminant generation model (within nodes) and routed downstream by a transport model (within links).

Show and Tell

In late November 2004, E2 is expected to have its first showing, when the Catchment Modelling Toolkit team demonstrate a work-in-progress model to the CRC Development Project teams. This workshop will include both practical, hands-on sessions, and discussions of the conceptual structure and component modules. The E2 workshop will be followed immediately by a TIME training workshop, which, in addition to training developers in the basics of TIME model development, will also explore some of the issues in adding modules to E2.

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PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER WALLBRINK

Report by Narendra Kumar Tuteja, Jai Vaze and Jin Teng

The CLASS modelling framework

Background

A range of bio-physical modelling approaches and tools at varying levels of complexity are required to provide critical support to various aspects of natural resource management planning. These include setting water yield and quality targets, monitoring, evaluation and review. The CLASS modelling approach is at the complex end of models, but it hides the complexity from the user and its graphical user interface simplifies handling the complexity.

CLASS is a distributed eco-hydrological modelling framework operational on the Microsoft.Net platform that can be used to investigate a range of environmental problems across paddock, hillslope and catchment scales (Figure 2.1). The Department of Infrastructure, Planning and Natural Resources (DIPNR) has developed CLASS with the work forming part of a CRC for

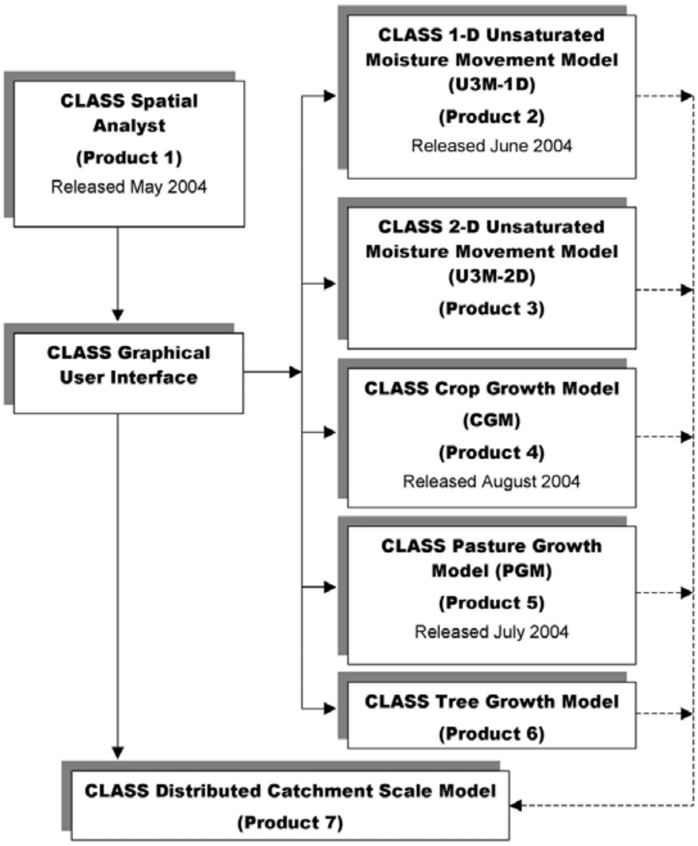

Figure 2.1 The CLASS modelling framework. Products already released by the authors are available on request.

Catchment Hydrology Associated/Additional Project through Program 2. The CLASS modelling framework, its components and their algorithms are described in a detailed CRC technical report (Tuteja *et al.*, 2004). CLASS has been reviewed both nationally and overseas.

CLASS uses a "bottom-up" modelling approach and offers an alternative to the commonly used simple "top down" modelling approaches. Distinctive features of CLASS include grid cell based analysis and the ability to allow for interactions within the model structure between energy (turbulent and radiation exchange), vertical and horizontal redistribution of soil moisture, plant growth, surface and groundwater fluxes, transport of conservative solutes and stream routing. Sufficient tools and databases exist in the CLASS framework to allow for generating information generally not available for catchment scale implementations (eg. flow path, soil depth, climate zoning, pedotransfer functions etc.). Tools in the CLASS modelling framework can be implemented at the hillslope scale relatively easily. However, at the catchment scale, CLASS is a computationally demanding modelling approach, and requires a good understanding of the modelling concepts.

CLASS tools along with CATSALT (Tuteja *et al.*, 2003; Vaze *et al.*, 2004) are being used in NSW to support reporting on performance against water and salinity related targets and for rolling audit updates under the MDBMC Basin Salinity Management Strategy and Murray-Darling Basin Agreement, Schedule C (eg. MDBC Salinity Audit Update 2004, Landscape Strategy for the Snowy Monaro Region).

The framework consists of seven tools that guide the user to build and investigate the effects of climate variability and land-use change both in the landscape as well as at the catchment outlet. Four of these tools have been professionally packaged on CDs and released by the authors and are available on request. Each released product is accompanied with a User's Manual written in plain English. In 2004-05, the tools in the CLASS framework are scheduled to be incorporated into the Catchment Modelling Toolkit.

Class Spatial Analyst

Class Spatial Analyst is a GIS based tool that can be used for spatial modelling. The current version is operational on ArcGIS 8.3 and the Microsoft .NET platform.

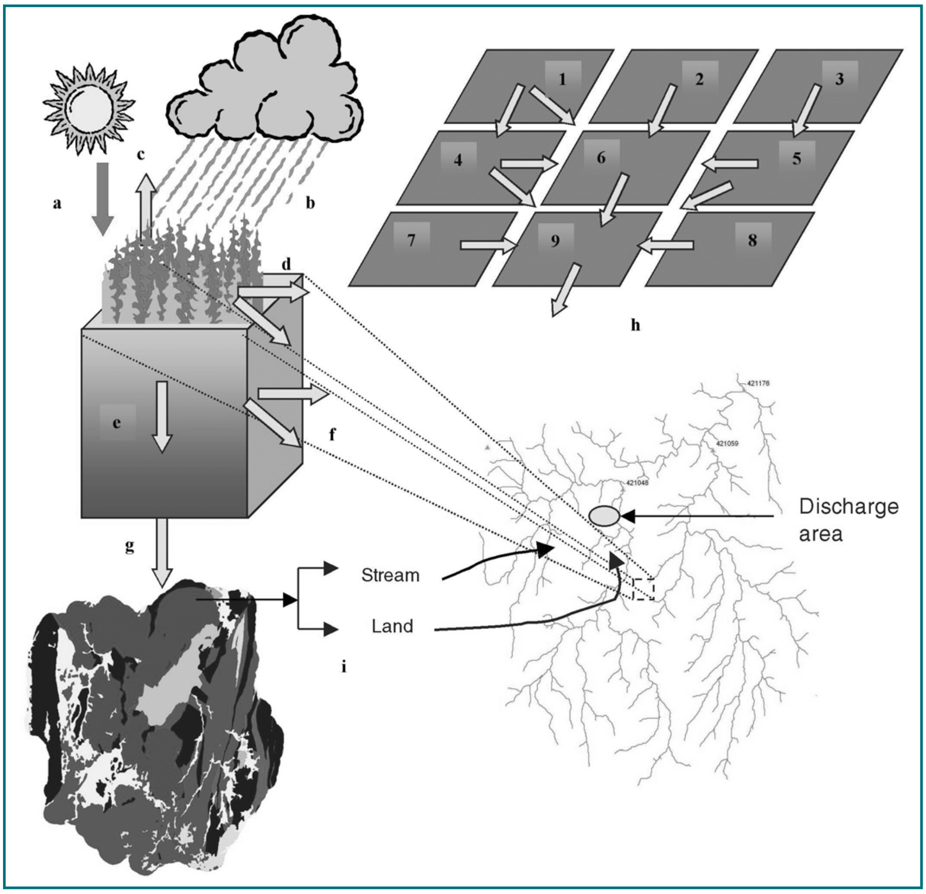

Figure 2.2 Schematic diagram of partitioning of the water balance components and simulated land use:- (a) solar radiation and climate data, (b) rainfall, (c) evapotranspiration, (d) overland flow, (e) flow through the soil, (f) shallow sub-surface flow, (g) drainage from the soil profile and recharge to the Groundwater Flow System (GFS), (h) water balance computational sequence (1-9), (i) discharge from groundwater to land and stream.

NEW TECHNICAL REPORT

Water Farms: A Review of the Physical Aspects of Water Harvesting and Runoff Enhancement in Rural Landscapes

By

Laura Richardson
Peter Hairsine
Timothy Ellis

Technical Report 04/6

Water farming is an approach to the problem of managing the quantity of water input to our streams, and is an idea that has been around for thousands of years. In this concept, land managers are able to generate more runoff for a given amount of rain than would happen in normal circumstances. Historically, most examples focused on providing extra water from a farm for use on the same farm. However, there are considerable prospects for 'water farms' enterprises that use water harvesting techniques to provide additional water into the river system and new water markets. It is these prospects that have prompted this review.

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

CRC WEB SITE UPDATE

The CRC web site at www.catchment.crc.org.au has recently been redesigned and updated. The new site contains additional information about our research outcomes from 1999-2002 as well as the current round of CRC projects.

The new site includes past copies of *Catchword*, all CRC publications since 1999, a contact directory for CRC staff, news and events pages and a Google powered search engine that includes Adobe Acrobat files.

Further information and project reports will also be added over the coming months.

For further information contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

The tool generates a number of spatial layers that can be used for many practical applications. These include climate zoning, multi-resolution DEMs, wetness index, lateral multiple flow paths, accumulation and dispersion of water and solutes from hazard areas, estimation of soil depth, soil material/horizon distribution and soil moisture storage capacity in different parts of the landscape. The technology used in this tool is supported by various international and national publications.

The tool also generates all the input files required by other models in the CLASS modelling framework. In particular, the multiple flow path algorithms determine the computational sequence that drives the water balance model to transfer water and solutes from upslope grid cells to the downslope grid cells and eventually to the catchment outlet. Additionally, the spatial distributions of the soils, landuse, climate and groundwater flow systems (GFS) links grid cell scale dynamics to the catchment scale effects (Figure 2.2).

CLASS 1-D Unsaturated Moisture Movement Model (U3M-1D)

This tool can be used for one-dimensional water and solute balance in the unsaturated zone using the Richard's equation. A variable sub-daily time step is used that senses transient nature of the climate conditions and increases or decreases the time step accordingly. A balance is conducted for each soil material/layer and evaporative, drainage and solute fluxes are simulated for each time step. Water balance error associated with the numerical approximation is quantified for each soil material/layer.

CLASS 2-D Unsaturated Moisture Movement Model (U3M-2D)

This tool can be used for two-dimensional water and solute balance in the unsaturated zone, also using the Richard's equation. Water balance along the vertical and horizontal axes is decoupled to allow for simulation of long hillslopes typically found in dryland catchments (~100-250m). This is achieved by introducing an upslope boundary condition in the vertical water balance wherein the contribution from upslope grid cell is included at a daily time step. Excess water, if any, is passed each day to the downslope grid cell using Darcy's law. All horizontal transfers of soil moisture and solutes from upslope grid cells to the downslope grid cells occur within each soil material/horizon.

CLASS Crop Growth Model (CGM)

This tool provides options for modelling the main field crop types grown in Australia and can be used to simulate crop growth for C3 temperate grass (monocotyledonous) and broad leafed (dicotyledonous) crops such as wheat, barley, canola and sunflowers, as well as C4 tropical grass crops such as sorghum and maize. These can be either determinate, where the onset of reproductive growth causes the cessation of vegetative growth, or indeterminate where there is a period during which both vegetative and reproductive growth occur. The model is based upon a detailed technical report on pasture and crop growth modules (Johnson, 2003). The model incorporates the Richard's equation based hydrology tool U3M-1D.

CLASS Pasture Growth Model (PGM)

This tool can be used to simulate growth of up to five species in a composite pasture that may be summer or winter active, perennial or annual or a legume. Like the crop growth model, the pasture growth model is based upon the detailed technical report on pasture and crop growth modules (Johnson, 2003). The model includes carbon assimilation through photosynthesis and respiration followed by tissue growth, turnover and senescence. Environmental conditions as well as soil water, nutrient and salinity status influence pasture growth and tissue dynamics. The tool allows the user to simulate a range of grazing management strategies. The model incorporates the Richard's equation based hydrology tool U3M-1D.

CLASS Tree Growth Model (3PG+)

This tool can be used to simulate tree growth using the 3-PG+ model (Morris, 2003), an adaptation of the 3PG model (Landsberg and Waring, 1997). The visual basic (VB6) code of the monthly tree growth 3-PG+ model has been re-coded in C# and made operational in Microsoft .Net. The monthly water balance model of the 3-PG+ model has been replaced with the sub-daily water balance model U3M-1D. Additionally, root water uptake, root distribution and plant water-stress functions in the 3-PG+ model have been replaced with functionality from U3M-1D.

CLASS Catchment Scale Distributed Eco-hydrological Model

The CLASS catchment model is a fully distributed model and is designed to predict the hydrologic effects of land-use change and climate variability. The model operates at the grid cell level and includes all the tools described above. The approach differs from earlier approaches in that the model is designed to operate in data poor environments with the appropriate level of complexity.

Acknowledgments

Concepts behind CLASS were developed by the core developer team at DIPNR in consultation with a range of scientists and professionals from DIPNR, Universities, CSIRO, CRC for Catchment Hydrology, DPI Victoria and Consultants. The work has been peer reviewed by international and national experts in distributed hydrologic modelling. The Department of Infrastructure, Planning and Natural Resources and the New South

Wales Government provided financial support for this work under the NSW Salinity Strategy.

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PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Asif Mohammed Zaman

Estimation of the impacts of temporary water trading in the irrigation sector

Introduction

This research project is looking at how to improve the estimation of the impacts of temporary water trading in the irrigation sector. On the whole, existing models used for this purpose have tended to over-estimate the volume and extent of temporary water trading. Furthermore, these models did not capture the intricacies and constraints of the irrigation distribution system. On the other hand, existing and established water allocation models (in Australia) do not incorporate temporary water trading.

The CRC for Catchment Hydrology Program 3, Sustainable Water Allocation, addresses some of these gaps in current knowledge by developing tools that integrate economic (trading) models with (engineering) water allocation models.

The Economic Model

In the first part of my research project, the main drivers for temporary water trading in the Goulburn-Broken Catchment in North Victoria were identified by analysing data from the online water exchange (Watermove). An important point to note about this type of trading is that it is not a market for physical transfer of water in itself. In fact the exchange consists of paper transactions. The physical transfer takes place when the buyer requests the volumes of water from the irrigation water supplier, and not necessarily when the transaction in the market occurs. The key trading drivers were identified using statistical analyses of historic trading activity.

At an aggregate level, the buyers in the temporary water market are driven by: the bid price, the time into the season, expected and actual water availability, lamb and wool prices, and previous water market prices and volumes. The suppliers, on the other hand, seem to be influenced by a lot more factors: the offer price, time into the season, expected water availability, irrigation deliveries, beef, feed and wool prices, local rainfall, and previous water market prices and volumes. More details about these trade drivers can be found in Zaman, Malano and Davidson (2004).

These trade drivers have been used to derive multi-

NEW TOOLKIT DATA PRODUCT

Soil Hydrological Properties for Australia

The first Catchment Modelling Toolkit data set has been released on the Catchment Modelling Toolkit website.

Soil Hydrological Properties for Australia (SHPA) provides continental coverage of soil properties relevant to catchment Modelling. This data set can be downloaded from www.toolkit.net.au/shpa

The data set provides estimates of twelve properties in total along with information on the uncertainty of the property estimates.

Further details of the data set development and its limitations are available in the data set documentation at www.toolkit.net.au/shpa

variate functions for the volume of water supplied and demanded in the market each week. These supply and demand functions form the basis of an economic model that estimates weekly trade volumes and prices for Zone 1 in Watermove. This is done by solving the supply and demand functions simultaneously (in the Q and P dimensions), given data for the independent variables. This model has been coded using the C Programming language. The model has been calibrated for the 2002/3 season. The graphs below show that, on the whole, the market activity for 2002/3 season is well modelled.

Although the economic trading model tends to over-predict, the pattern of the estimated (net) volumes are well matched. However, as yet, there has been limited success at independent validation using data from other seasons.

The Integration

The second part of the research project involves integrating the economic trading model to an existing water allocation model for the Goulburn-Broken Catchment (the Goulburn Simulation Model, GSM). So far, I have investigated two options for incorporating trading estimated by the economic model:

- changing the crop water requirements; and
- adjusting water delivery restrictions.

In terms of reflecting actual trade and delivery patterns, there has been more success with the latter approach. For the 2002/3 season, the results of the integrated model show that the trade volumes, estimated by the economic model, were not restricted by the irrigation distribution system. Currently, the options and implications of when an economically viable trade volume can not be accommodated in the integrated model are being investigated.

After that, scenario analyses with the integrated model will be conducted to estimate the likely directions of water movements throughout the season due to changes in the water trading environment, e.g. variation in commodity prices, climatic changes, distribution system alterations. Although the volumes traded in past years amount to about 15-20% of total irrigation water delivery, in certain months of the season, this percentage can be significantly higher. This has implications for managing irrigation systems and for evaluating the total net benefit that can be derived from available water for irrigation.

I look forward to receiving some feedback and fresh ideas that you may have.

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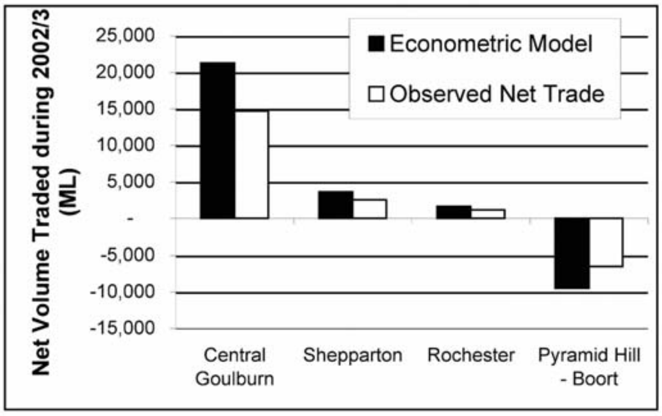

Figure 3.1 Annual net trade volumes during 2002/3 season

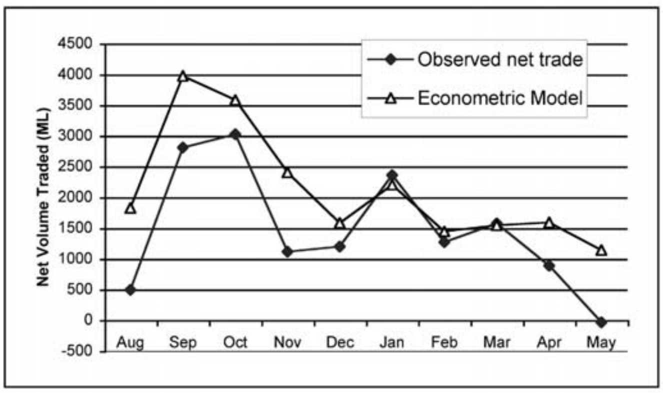

Figure 3.2 Monthly model results for Central Goulburn District

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Hugh Duncan

Water Quality in Urban Low Flows - The Hampton Park Experience

Background

The Hampton Park Wetland, on the southeastern fringe of Melbourne, has been intensively sampled by the CRC for Catchment Hydrology during runoff events in 2003 and 2004. An aerial view of the wetland is shown in Figure 4.1. Flow enters the wetland through the two similar inlet branches to the lower right of the photo, and leaves through a riser structure in the open water pond to the upper left.

Figure 4.1. Hampton Park Wetland

Some of the sampled events appear to show an increase in total nitrogen concentration during the flow recession towards the end of the event. See for example the graph of inflows and total nitrogen concentrations for one event in Figure 4.2. To investigate this apparent increase further, the automatic samplers on site were reconfigured to take one sample a day for 24 days, starting in late April 2004. This article presents a summary of the results obtained.

Although the two inlet branches are very similar in most respects, there is another small wetland upstream of the more northerly branch just out of the aerial photograph, which attenuates the inflows and loads in that branch. Because of this, most of the results summarised here are taken from the south branch of the wetland.

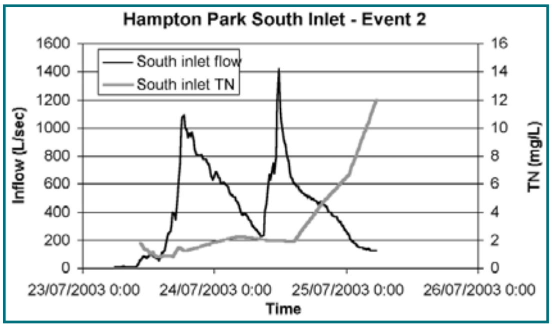

Figure 4.2. Storm Event TN Inflow Concentrations

Inflow Concentrations

The daily sampled inflow concentrations of total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN) are shown in Figures 4.3 to 4.5, along with 15-minute inflow data prior to and during the sampling period. The principal objective of the daily sampling is to study concentrations during the low flow periods. At this sampling frequency, good resolution of behaviour during the runoff events cannot be expected.

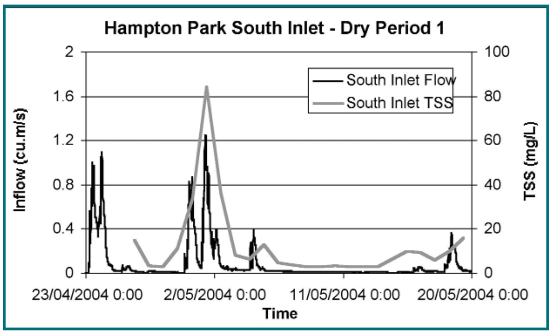

Figure 4.3. Dry Period TSS Inflow Concentrations

Inflow concentrations of TSS (Figure 4.3) behave very much as expected. High concentrations during stormflow fall rapidly to low levels after the event and remain low throughout the baseflow period. Baseflow concentrations of TSS are typically 2 to 3 mg/L.

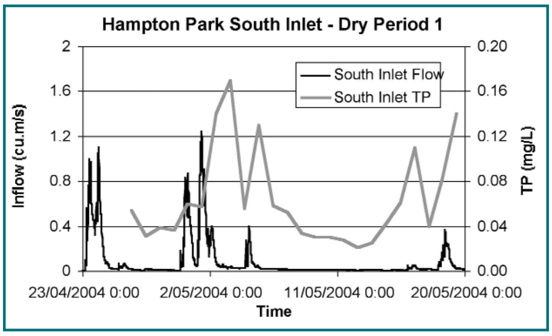

Figure 4.4. Dry Period TP Inflow Concentrations

Inflow concentrations of TP (Figure 4.4) appear to be distinctly lagged with respect to the runoff event, with peak concentrations occurring two to three days after

MUSIC TRAINING COURSES - REGISTRATIONS CLOSING

This two day MUSIC (Model for Urban Stormwater Improvement Conceptualisation) training workshop is aimed at professionals in local government, consultancies and waterway and catchment management agencies.

Melbourne
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5-6 October 2004
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peak flows. Baseflow concentrations of TP eventually return to around 0.02 to 0.03 mg/L.

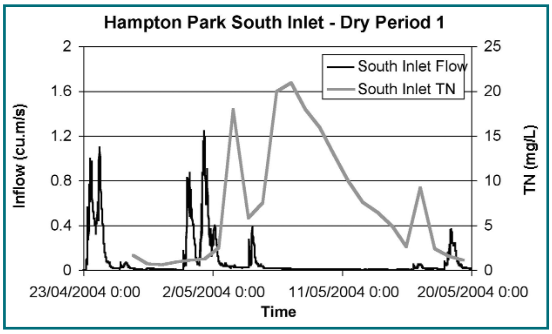

Figure 4.5. Dry Period TN Inflow Concentrations

Inflow concentrations of TN (Figure 4.5) show a prominent and strongly lagged peak. Concentrations increase to a maximum of over 20 mg/L about six days after the event, then gradually decrease again as the dry period continues. Concentrations finally return to about 1 mg/L at the end of the sampling run, after a pollutograph spanning well over two weeks.

Treatment in the Wetland

Since water quality samples were collected at intermediate sites, the behaviour of the inflows can be traced as they pass through the wetland. It is interesting to see how the wetland performs under conditions distinctly different from those assumed during design. Figure 4.6 shows concentrations of TN at the inlet of the south branch, between the inlet pond and the ephemeral wetland, and close to the junction where the two inlet branches join to form the main or west wetland.

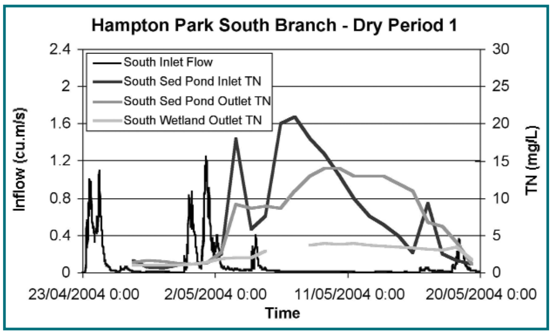

Figure 4.6. Dry Period TN South Branch Concentrations

The large peak in TN concentration which occurs well after the stormflow event has been delayed and attenuated by the inlet pond, and substantially reduced by the wetland. Significant treatment is possible, even in the small south branch system, because flows are very low when the concentration peak occurs.

Loads

The load of a given contaminant passing a point in a short time step is the product of the flow and the concentration in that time step. For contaminants that increase in concentration during a runoff event, the load is very strongly associated with the event runoff or stormflow, since both flow and concentration increase at the same time. Contaminants associated with baseflow behave rather differently, but have rarely been considered critical contaminants in urban runoff.

At Hampton Park we have a critical contaminant for this area – total nitrogen – which peaks during baseflow. What then is the effect on loads? Loads have been estimated for this data period using observed 15-minute flows, and concentrations linearly interpolated between the daily observations. Linear interpolation of concentrations will give only a broad indication of loads during stormflow periods, as daily samples do not capture the short term variation which is likely during stormflow, but the loads calculated during the low flow periods will be considerably more accurate.

Figure 4.7 shows the estimated load of TN entering the south branch during the sampling period. The period of elevated load is greatly extended beyond the flow peak, and regardless of the accuracy of loads calculated during the peak, the loads delivered during low flows now form a substantial fraction of the total.

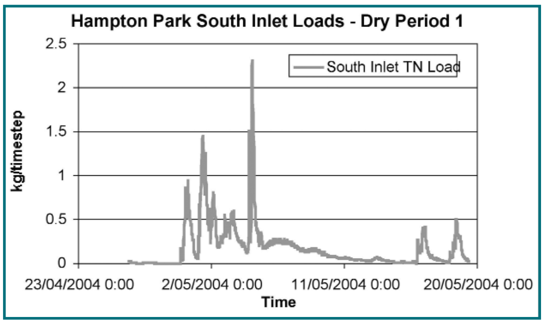

Figure 4.7. Dry Period TN Inflow Loads

Implications

The behaviour observed here cannot be treated as an isolated event. It was the repeated observation of rising TN concentrations after a runoff event at this site that led to these results being recorded. The same effect is now being observed in recent data from Ruffey's Creek in Melbourne's eastern suburbs. And a similar although less prominent effect is also present in the established data set from Blackburn Lake, again in the eastern suburbs of Melbourne. At least in this geographic area, a large but heavily lagged peak in total nitrogen concentration appears to be very common, although a sampling program carefully directed towards stormflow behaviour may not detect it.

The data from Ruffey's Creek is particularly valuable, because nitrogen speciation has been carried out at this site. In every event measured, the initial peak associated with stormflow is mostly organic nitrogen, while the delayed increase associated with low flow is mostly oxidised nitrogen.

The simple timing of the pollutograph and the dominance of oxidised nitrogen both suggest that the lagged peak is caused by an interflow process, but a complete explanation of the behaviour at each site is not yet available. More investigation is clearly required. Options include further long-term sampling of inflows, and sampling of groundwater near the wetland and watercourses. In the meantime, the results raise one obvious question. Just how common are elevated concentrations of total nitrogen in urban low flows?

Conclusions

High concentrations of total nitrogen have been observed during periods of low flow at several sites in the eastern and southeastern suburbs of Melbourne. Where fully measured, they take the form of an extended pollutograph lasting two to three weeks and lagged by up to a week after a runoff event. Since a sampling program directed to stormflows may not detect this behaviour, it may be more common than has been realised. A significant fraction of total nitrogen load can be delivered during this low flow period.

Acknowledgements

The monitoring program at Hampton Park and Ruffeys Wetland have both been supported by Melbourne Water. In particular, we'd like to thank Marc Noyce and Graham Rooney. Hampton Park data was collected and processed by Peter Poelsma, whilst the Ruffeys data has been collected by Geoff Taylor as part of his PhD research.

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URBAN STORMWATER SOFTWARE

Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 2.0.1

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 Version 2.0.1 is available as a free evaluation Version download from the Catchment Modelling Toolkit web site at www.toolkit.net.au/music

The MUSIC evaluation version allows you to trial the MUSIC software for 6 weeks. During that period you are able to purchase the MUSIC software for $330. Discounts apply if you are a current MUSIC Version 1 user.

For further information visit the MUSIC web site at www.toolkit.net.au/music

Please note: You must be a registered Catchment Modelling Toolkit member to download the MUSIC evaluation version.

NEW TOOLKIT SOFTWARE

Stochastic Climate Library (SCL)

The Stochastic Climate Library (SCL version 1.0.3b) and its associated user guide can now be downloaded from www.toolkit.net.au/scl

For details of changes made to this version of SCL please look under 'Version History' on this page.

Stochastic climate data can be used as inputs into hydrological and ecological models to quantify uncertainty in environmental systems associated with climate variability.

SCL is a library of stochastic models for generating climate data. Version 1.0.3b of SCL has stochastic models for generating rainfall and climate data at a site at annual, monthly and daily time steps. Other stochastic models will be added to future versions of SCL, after model development and testing.

For further information about SCL and its application visit www.toolkit.net.au/scl

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Andrew Western

Improving runoff simulation in large-scale hydrological models

Runoff estimates from existing weather forecasting models

The Bureau of Meteorology routinely runs simulations over Australia and the surrounding seas twice a day for weather forecasting. 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, VB95, which is based on the European Centre for Medium Range Forecasting land surface scheme, provides estimates of runoff, soil moisture and evapotranspiration, along with all the surface energy balance terms. At present the estimates of runoff from this model are of unknown quality. Also, it is likely that they can be improved significantly given the structure of the model, which was originally developed with a focus on land-atmosphere exchanges of water and energy. We are undertaking a study to (i) test the quality of the predicted runoff against observed catchment runoff and (ii) to improve the runoff process algorithms in the model.

Background to existing forecasting models

Models like 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. For this reason they tend to be poor at predicting catchment runoff. However, because they are routinely run by weather agencies around the world, they provide comprehensive simulations of hydrologic response at spatial scales down to about 100km^2. These simulations provide a real-time picture of the hydrologic state of our landscapes along with current and forecast runoff, albeit of questionable accuracy. With appropriate improvements to the modelling, such a product could be provided by the Bureau of Meteorology and would find many beneficial uses, provided the quality was sufficient.

Model testing and improvements

The first phase of this study involves testing VB95 against observed runoff. This will be undertaken using gauged catchments from the mid- and upper-Murrumbidgee focus catchment. We have already undertaken a variety of work with VB95 in the Murrumbidgee targeted at testing and improving simulation of soil moisture (Richter *et al.*, in press). This work has used data from the soil moisture monitoring network run by the CRC and the University of Melbourne (Western *et al.*, 2002) and forcing data sets developed for our monitoring sites (Siriwardena *et al.*, 2003). Figure 5.1 shows a map of gauged unregulated catchments in this region, overlain on the annual rainfall. These catchments provide a range of climate over which to test the VB95 model. We are starting to run simulations over a ten year historic period for some of these catchments and plan to evaluate the model performance over a range of timescales down to daily. This will provide a baseline against which to assess model improvements.

The second phase of this study involves work to improve the runoff simulation algorithms in VB95. Currently VB95 uses an areally lumped one-dimensional simulation of the soil profile based on Richard's Equation and a four-layer soil profile. The key problem with this modelling approach is that the dominant runoff flow path simulated by the model is drainage out the bottom of the soil profile. There is no effective description of either infiltration excess runoff or saturation excess runoff. There are a number of reasons for this, but two are probably critical.

The areal lumping ignores spatial variation in rainfall intensity (the areal average intensity tends to be low) and soil moisture. Because both saturation excess and infiltration excess runoff are threshold processes, the spatial variability is important. While all conceptual catchment rainfall-runoff models (such as SIMHYD, AWBM, Sacramento and TopModel) are areally lumped descriptions of the hydrology, they usually incorporate linear or non-linear functions that lead to a percentage of rainfall becoming runoff depending on the soil water status. This feature allows these models to incorporate the effect of spatial variability to a reasonable degree and thereby overcomes the effects of areal lumping.

Another limitation of VB95 is the fact that it allows a large amount of drainage. This occurs because VB95 uses a soil profile with uniform properties and free drainage at the base. Most natural soils have some impeding layers or a general decrease in hydraulic conductivity with depth, or reach bedrock at a reasonably shallow depth. These features tend to reduce drainage and lead to water being retained in the profile. Water also moves laterally down-slope and quite often to surface saturation in parts of the landscape near streams, which then become runoff producing zones.

We plan to make changes to the way in which both the infiltration process and the deep drainage process are simulated in VB95 to address both these shortcomings.

For the changes we plan to draw from our previous experience with models such as SIMHYD. We will also use our past research on spatial variability of soil moisture and its impact on runoff processes and on temporal variability of rainfall intensity and its impact on modelling infiltration.

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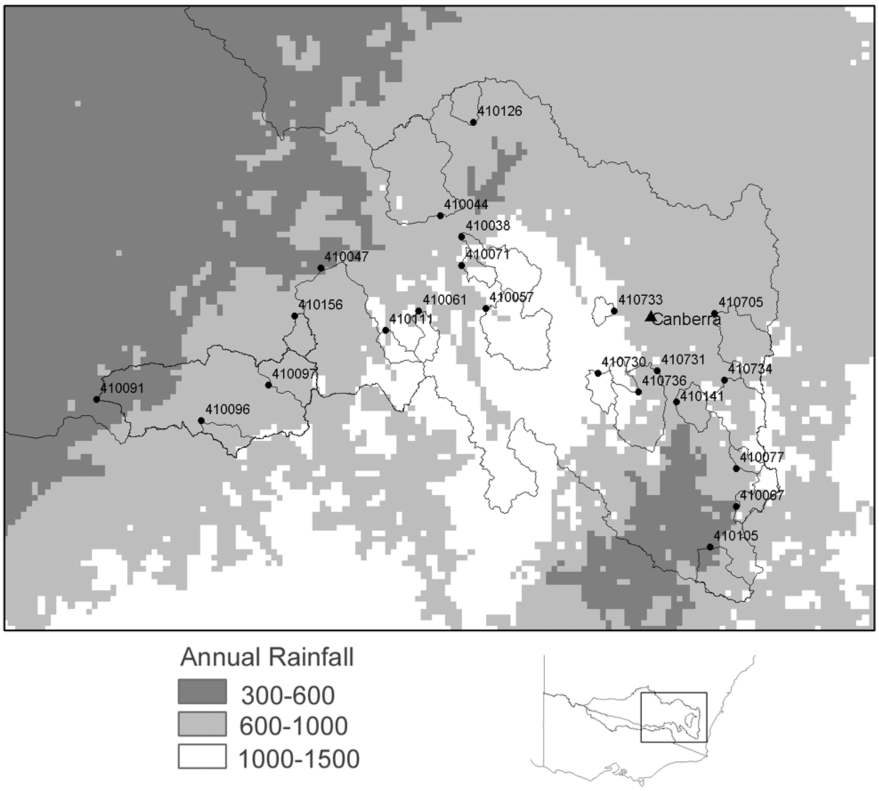

Figure5. 1: Gauged unregulated catchments in the mid- and upper-Murrumbidgee focus catchment.

NEW TECHNICAL REPORT

Stochastic Generation of Point Rainfall Data at Subdaily Timescales: A Comparison of DRIP and NSRP

By
Andrew Frost
Ratnasingham Srikanthan
Paul Cowpertwait

Technical Report 04/9

One of the goals of the Climate Variability Program in the Cooperative Research Centre (CRC) for Catchment Hydrology is to develop and test computer programs for generating stochastic climate data at timescales from less than one hour to one year and for point sites to large catchments. The appropriate models will be part of SCL (Stochastic Climate Library - a suite of stochastic climate data generation models), a product in the CRC's Modelling Toolkit (see www.toolkit.net.au/scl).

This report describes the evaluation of two point subdaily stochastic rainfall models - the Newman-Scott Rectangular Pulse (NSRP) and the Disaggregated Rectangular Intensity Pulse (DRIP). The models are evaluated using relatively long pluviograph data from ten major Australian cities and regional centres.

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PROGRAM 6

RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Brett Anderson, Ian Rutherfurd and Andrew Western

How does riparian vegetation condition influence floods?

Background

The riparian zone of Australia's river networks has become a focal point for environmental rehabilitation efforts in the last decade. A tide of research links the impoverishment of riparian vegetation to declines in the health of aquatic and terrestrial ecosystems, including the deterioration in the physical integrity of stream channels. The economic cost of poor management of riparian lands in water harvesting catchments alone has been estimated at around $45 million per annum. Large-scale riparian restoration projects are not just being contemplated, but funded and completed. To pick just one example the North-Central Catchment Management Authority in Victoria has embarked on a project that aims to erect 112km of riparian fencing and to enhance 86ha of riparian vegetation on the Loddon River between 2003 and 2005.

The reinstatement of riparian vegetation flies in the face of historical river management principles. River channel roughness, a measure of resistance to flow, is substantially increased by bank vegetation and by the large woody debris that accumulates on the bed where healthy riparian systems exist. However, increased roughness means that a lower flow volume can be conveyed through the channel before flooding commences. Flood mitigation is both an economic imperative and a safety issue for river managers and river-side residents. It is not unusual for a single flood event to cause damage to agriculture, stock and infrastructure that tallies into the hundreds of millions of dollars, as well as threatening lives. For these reasons, the heart of many past river management strategies has been the pursuit of hydraulic efficiency - the maximisation of the discharge capacity of a channel. The ultimate expression of this policy occurs in urban areas, where concrete channels have replaced streams and creeks in order that flood peaks can be safely transmitted. In rural areas the drive for hydraulic efficiency has left a number of legacies from impoverished riparian plant communities, to de-snagged stream beds and straightened river courses. Our research questions the efficacy of such hydraulic efficiency programs, proposing an alternate paradigm for river management. The analysis that follows is based on expanding the focus from considering only local effects to include whole-of-catchment processes. It addresses the question: does large-scale riparian restoration have an impact on floods?

The role of vegetation in flood development

Floods are driven by rainfall events, controlled by the delivery of water from hillslopes and the transmission of flow through channel networks. The condition of vegetation in the riparian zone influences runoff flux as well as modifying the form (shape of the cross-section) and roughness of channels and floodplains. Plants interact physically with flow and have an impact via the demand for water by physiologic processes (e.g. evapotranspiration). However, it is important to recognise that flood waves evolve as a result of contributions from all parts of the upstream network. Therefore if changes to runoff flux, channel shape or roughness are to modify a flood wave, the mechanism must have catchment-scale leverage. The principle of leverage is similar to voting: just as an individual voter does not have the power to decide an election, the outcome is decided by the concerted voices of the majority. Similarly, for vegetation to meaningfully affect floods, the magnitude of the impact must be clear at a local scale, and the direction of the change must act to consistently accelerate or attenuate flow response over large lengths of stream.

Application of these leverage criteria eliminate near-stream hydrology and changes to channel morphology from consideration. As regards near-stream hydrology, the presence of vegetation acts both to accelerate and impede delivery of water to the stream. For instance, tree root networks provide preferential pathways along which sub-surface flow is piped with great speed, while at the same time increased evapotranspiration decreases soil moisture levels, effectively reducing the rate of flow delivery to the channel. Depending on the balance of these contrary effects, the reinstatement of riparian trees may increase or decrease runoff, and existing hydrologic knowledge does not allow us to judge which effect is dominant. Turning to channel morphology, for small streams there is evidence that the presence of vegetation causes channels to be deeper and narrower, however these impacts only arise in some channels and for particular vegetation assemblages. In general, channel form is the result of a complex interaction between factors including flow, geology and vegetation. As yet no clear trends have emerged that allow the impact of vegetation to be reliably predicted over large stream lengths. Thus, only vegetation roughness remains as a candidate with potential leverage. The presence of healthy riparian vegetation consistently increases flow roughness, a parameter directly, and inversely, related to channel conveyance (discharge capacity). In addition the impact is substantial, with the roughness of well-vegetated streams often double that of cleared streams. For these reasons our research focussed on vegetation-induced roughness change.

How rough is vegetation?

A comprehensive review of field and laboratory studies showed that the value of roughness associated with a stand of plants depends principally on whether they are emergent or submerged. The hydraulic resistance of flow through emergent plants depends on the foliage density and on the structure and stiffness of stems or branches (Jarvela, 2002; Wu, Shen, & Chou, 1999). Many plants respond dynamically to increased flow velocity, with the flexure of stems and branches, and streamlining of leaves, dramatically reducing the net drag (Kouwen & Fathi-Moghadam, 2000). The evidence suggests that channels with dense vegetation cover can exhibit channel roughness values (Manning's n) of between 0.15–0.20. Such resistance is 2 to 5 times greater than the value of roughness in the equivalent sand, gravel or cobble bed stream without vegetation (Bathurst, 1993). However, flow roughness declines rapidly as the plants become submerged. A layer of unobstructed flow is able to develop above the vegetation canopy. Thus plant height represents a critical dimension, with vegetation roughness characteristics varying principally with flow depth. The depth-varying roughness profile (solid line) shown in Figure 6.1 a summarises these essential features. The dashed line represents the single-valued roughness profile usually assigned to a location free of vegetation, and the shaded area highlights the increase in roughness caused by a vegetation stand.

Both the distribution of plants around the channel cross-section and the shape and size of the cross-section determine whether the contribution of vegetation to overall channel roughness is large or small. A numerical model was constructed, based on these factors and the depth-varying profile in Figure 6.1a, to predict the vegetation increment. Input parameters to the model, that is vegetation distribution and channel form, both vary down the stream network. For example, vegetation is less able to encroach on large lowland channels as flow is generally more persistent than on smaller headwater streams. However, in both large and small streams, the height of a tree, or a stand of reeds are essentially constant. By contrast, the downstream expansion in channel dimensions is dramatic. Headwater streams may have a bankfull width of less than one metre, and a depth of ten's of centimetres. At the other end of the catchment, lowland rivers can be hundreds of meters wide and many metres deep. Thus, cross-section expansion spans two orders of magnitude, while the dimensions of riparian stands remains, by comparison, essentially constant. Reflecting these characteristics, the vegetation increments computed by the numerical model are largest for small rather than large streams. This is an important result because over 70% of the total channel length in most catchments is in first and second order streams, yet flood problems are most severe in lowland rivers where minor roughness change is predicted.

The impact of vegetation roughness on flood waves

Having quantified the change in channel roughness, differences in channel capacity are readily calculated. The depth-varying roughness profile modifies the stage-

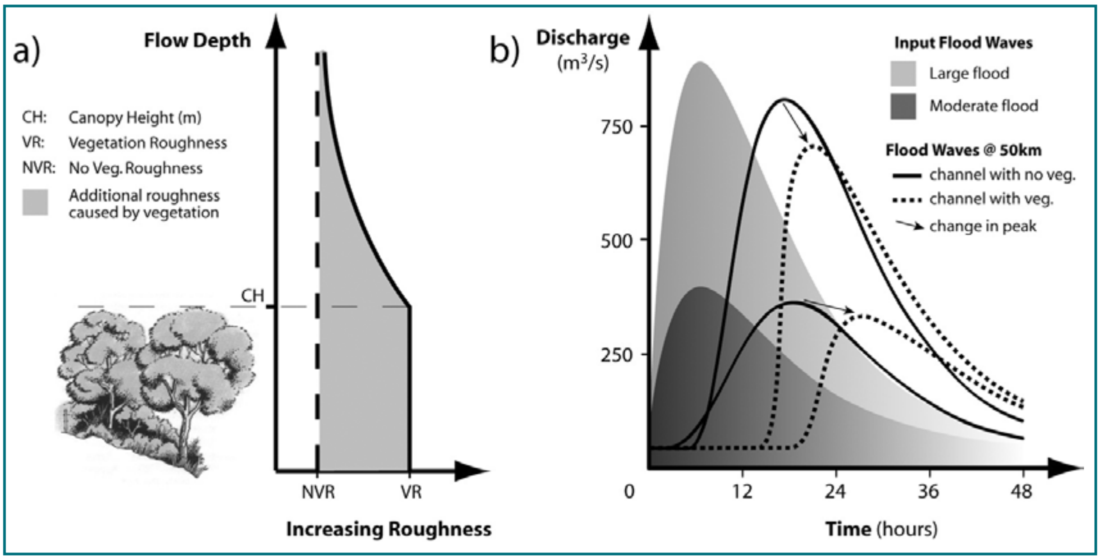

Figure 6.1 a) Model for the variation of vegetation roughness with flow depth. b) Results of routing two flood waves down a 50km of reach, with and without vegetation roughness.

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.

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discharge relationship which in turn dictates, at a local scale, the depth and duration of flow for a given inflow hydrograph (the flood wave that arrives at the top of the reach). The inflow hydrograph is the sum of the flows accumulated through the upstream channel network, and herein lies the crux of the problem. If the upstream channel network is well vegetated, the inflow hydrograph produced in response to a given rain event is quite different from that produced by a channel network with little vegetation. A series of numerical flood routing experiments were conducted.

It is well known that flood waves move more slowly down rough channels, and the peak flow decreases (attenuates) more rapidly (Romanowicz, Beven, & Tawn, 1996; Rutherfurd, Hoang, Prosser, Abernethy, & Jayasuriya, 1996). In fact, it is possible to predict the change using theoretically-derived relationships where channel roughness is constant (Yen & Tsai, 2001). However, for channels with vegetation, roughness varies with depth and the veracity of the theory was unknown. Therefore, several thousand flood waves were numerically routed down river reaches having depth-varying roughness profiles designed to resemble well-vegetated channels. The output was analysed to determine differences in wave speed and attenuation for both vegetated and unvegetated cases. Figure 6.1b reproduces two sets of hydrographs routed down a 50km reach. These results confirm the initial premise, showing that in rougher channels the hydrograph arrives later (lower wave speed) and the peak flow is more highly attenuated than for channels clear of vegetation. Response to large floods differed from small floods, as is evident in Figure 6.1b. The difference is attributed to the fact that large floods submerge the vegetation, and are therefore subject to much lower roughness. A correlation study found that the differences in wave speed and attenuation could be predicted with reasonable accuracy by substituting the temporal average value of roughness across the flood wave into existing theoretical equations.

The upstream story … how healthy riparian vegetation helps

The difference between flood wave translation down a well vegetated and an unvegetated reach is distinguished by two parameters: wave speed and attenuation. A catchment-scale flow routing scheme known as the convective-diffusive approach is based on these parameters (Naden, 1992; Robinson, Sivapalan, & Snell, 1995). This tool was used, in conjunction with the channel network of the upper Murrumbidgee River (above Wagga Wagga, see Figure 6.2a), to explore the likely ramifications of whole-of-catchment riparian revegetation.

Two models of the upper Murrumbidgee catchment were generated, one with vegetation and one without. Rainfall events ranging in depth (mm/hr) and duration were routed through each catchment instance, resulting in two different inflow hydrographs at Wagga Wagga. Figure 6.2b shows these two hydrographs as the solid lines, with the lower curve the delayed and more highly attenuated hydrograph from the well vegetated network (see 'upstream decrease'). The dashed lines represent the increase in stage that results when the stage-discharge relationship is adjusted at the outlet to account for vegetation roughness (see 'local increase'). In this particular case, the attenuation through the upstream network overshadows the local deterioration, therefore overall the flood hydrograph at Wagga Wagga has a substantially lower peak. The network impact is not always dominant. For example, the

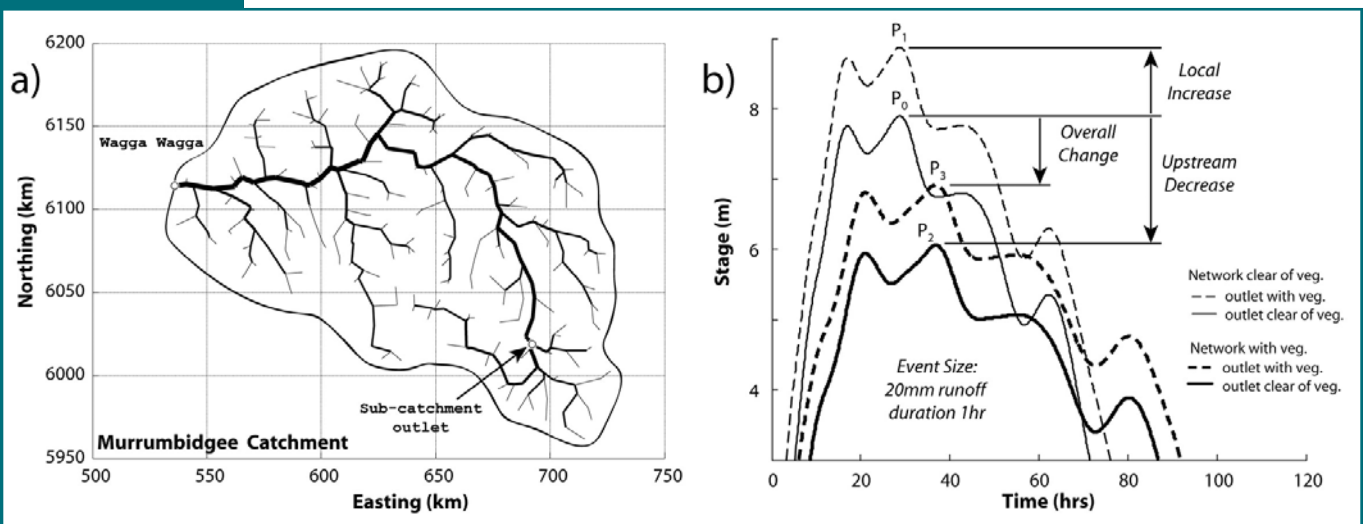

Figure 6.2 a) Channel network of the upper Murrumbidgee; and b) stage hydrographs at Wagga Wagga comparing the relative importance of local and upstream vegetation condition.

balance is in favour of the local impact at the point marked 'sub-catchment outlet' in Figure 6.2a. In fact, interesting locations to find are where the local increase in the peak just balances out the upstream decrease. However, the main point demonstrated by this case study is that channel networks with healthy riparian vegetation are likely to produce smaller inflow hydrographs, and in some cases the flood peak will be smaller despite the additional roughness incurred by local riparian planting.

Implications for riparian restoration …'think global, act local'

The tangible outcomes from this work include two new predictive models: firstly a new approach for estimating the contribution of vegetation to channel roughness, and secondly a model that facilitates the investigation the impact of large-scale revegetation efforts on floods, a model that is equally applicable in Australia and around the world. In general, the findings will assist management organisations to prioritise and design revegetation programs. For example, revegetation efforts could be targeted so as to provide some protection for downstream assets (i.e. to relieve the pressure on existing flood retention infrastructure), or simply to get the best 'bang for your buck' (i.e. target smaller tributaries where vegetation has more clout).

The Murrumbidgee River case study quantified a case of complete catchment restoration. While restoration at such a scale may be impossible to achieve in the short term, this work demonstrates that the rehabilitation of riparian revegetation is not all down-side as far as flooding is concerned. Putting aside the models and the math, the most powerful outcome is that it arms restoration advocates with an argument. An argument that concrete-lined channels are not a panacea for flood protection, in fact the opposite is true.

Human impacts on rivers are ubiquitous and potent, with clear ramifications for catchment-scale functions like flooding. This research adds a voice to the cry for integrated catchment management, demonstrating that global thinking is required to correctly direct local actions.

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SPECIAL PUBLICATION AVAILABLE ON-LINE

Spatial Patterns in Catchment Hydrology

Edited By
Rodger Grayson
Günter Blöschl

This publication (404pp) brings together a number of recent field exercises in research catchments, that illustrate how the understanding and modelling capability of spatial processes can be improved by the use of observed patterns of hydrological response. In addition the introductory chapters review the nature of the hydrological variability, and introduce basic concepts related to measuring and modelling spatial hydrologic processes.

Written in an intuitive and coherent manner, the book is ideal for researchers, graduate students and advanced undergraduates in hydrology, and a range of water related disciplines such as physical geography, earth sciences, and environmental and civil engineering as related to water resources and hydrology.

This publication can be downloaded at no cost from the CRC web site. Follow the 'Special Publication' link from www.catchment.crc.org.au

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect - September 2004

At a glance – a summary of this article

Rodger Grayson's 'Note from the Director' in this issue of *Catchword* provides an overview of the recently completed review of our CRC's communication activities. This article expands on the external stakeholder survey results and makes comparisons with a similar review in 2001. In particular, thank you to those people who contributed their time in completing the survey.

Introduction

The CRC Business Plan clearly commits us to regular reviews by independent consultants of the effectiveness of our communication activities. The first of these reviews was conducted in early 2001 and key results were summarised in this column in the August 2001 *Catchword*. Another review was scheduled for this year, providing us with an opportunity to evaluate our communication and for the first time, the extent of its impact and, in some areas, a comparison of our performance with three years ago.

We engaged the market research group Newton Wayman Chong and Associates (NWC) to evaluate the effectiveness of the various communication streams we use to provide information to our primary stakeholder groups. These groups were defined as: external stakeholders (recipients of *Catchword* and members of the Catchment Modelling Toolkit website); internal stakeholders (CRC staff); and primary stakeholders (those with a strong vested interest in the CRC, our Board members for example).

Methodology

Firstly I would like to thank all of those people who contributed to this review by completing a survey. Without your participation we would not be able to gain a clear insight into the value of our communication activities and how we can improve them to better meet our audience's needs.

On the advice of the consultants, the review methodology changed slightly from 2001. Last time, external stakeholders were surveyed using a self-completion email survey, however in order to get a larger and more representative sample the 2004 survey utilised a telephone methodology. Self-completion surveys tend to be skewed towards respondents who have strong opinions, either positive or negative. Based on the results of the 2001 survey NWC suggest that it was likely to be a positive bias among the 175 respondents.

External Stakeholders

Consequently 300 external stakeholders were selected at random from a CRC database of 1600 possible participants and were invited to complete a 15 minute telephone survey. The survey covered of a number of key areas: overall satisfaction with our communication, the relevance, application, impact and potential impact of the CRC's research, the effectiveness of the different communications streams (*Catchword*, the Catchment Modelling Toolkit website, seminars workshops etc), how the CRC compares to other similar organisations, and suggestions for improvement.

Profile

Respondents selected for the external stakeholder survey came from around Australia: Victoria 33%, NSW 31%, Queensland 19%, South Australia 6% and all other states, 5% or less. Participants were asked to describe their organisations - 32% said "private company – technical service provider", 26% "State government", 10% "local government", 10% "research organisation" and the reminder relatively evenly spread across "catchment/river management", "water utility", "education", "Commonwealth" and "land holder/manager" categories. A question was also asked about the size of the organisations respondents worked for, revealing that 67% came from organisations of over 100 employees, 11% from 20-50 employees and the remaining 22% from organisations with less than 20.

Relevance

The level of relevance of the CRC's research to respondents work was high and consistent with 2001. Half of the respondents (53%) said that the research is 'very relevant' or 'mostly relevant'. The twenty-six respondents (9%) who rated the research as 'little' or 'no' value were asked why they felt that way. Three quarters of this latter group said that the research was not relevant to their core business.

Application

Two-thirds (69%) of the external stakeholders claimed to have applied "all, most or some" of the CRC's information or products. In addition 22% of respondents reported they had applied it "to a small extent". This result is consistent with the 2001 result and we consider it very positive (Figure 7.1). Survey participants were then asked to consider the impact of applying that information or products. Four in ten (40%) believed it had a "major or strong impact" and another 42% said a "minor" impact (Figure 7.2). Only 18% suggested the research had little or no impact - which is a great result and a strong indication that the CRC is developing knowledge and products that are making a significant contribution to the land and water industry.

Potential use and impact

Personally, I was pleasantly surprised by the survey results from respondents about their future intentions to apply the CRC's research and its potential impact. Over 80% of external stakeholders said they "intend to use the information or products from the CRC in the future". When asked about the expected impact of applying that research, 65% said they expected it would have a "major or strong" impact (10% and 55% respectively; Figure 7.3). These questions were not included in the 2001 survey.

General satisfaction

A question about the general level of satisfaction with the CRC's communication activities revealed that 83% of respondents were either satisfied (58%) or very satisfied (25%). These results were similar to the 2001 survey. When asked to compare the CRC with similar organisations, 69% of external stakeholders in 2004 survey described the CRC's communications as "better" (28%) or "much better" (41%). One quarter (27%) said "about the same".

Catchment Modelling Toolkit Website

There were 178 respondents among the 300 external stakeholders who had visited the Catchment Modelling Toolkit website. They were asked a series of questions to establish their satisfaction with the site. The Toolkit website is one of our most important delivery vehicles for our research and has been under intensive development over the last twelve months. It was a good opportunity to assess its effectiveness. Four in ten respondents (41%) visit the Toolkit website "at least every month" and a further 30% "at least every three months". This is in line with my expectations as the Toolkit website contains a wide range of products each of which is relevant to particular technical groups in our

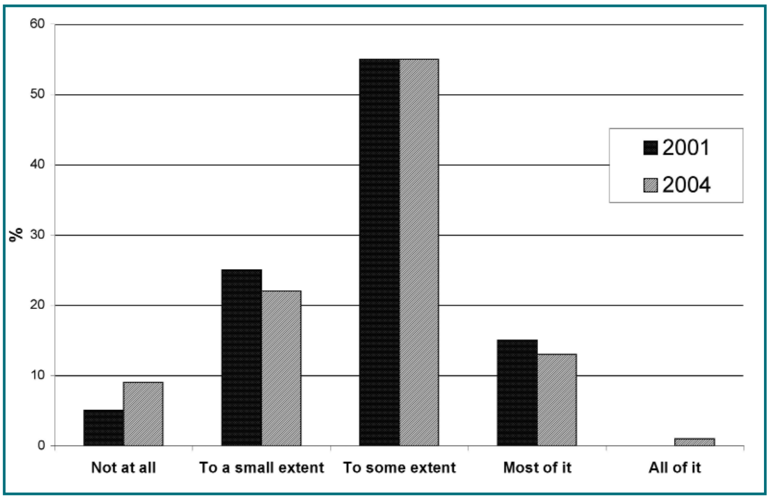

Figure 7.1 "Have you applied or used any of the information or products that the CRC has generated to date? Have you used…?" 2001 sample size = 175; 2004 sample size = 300

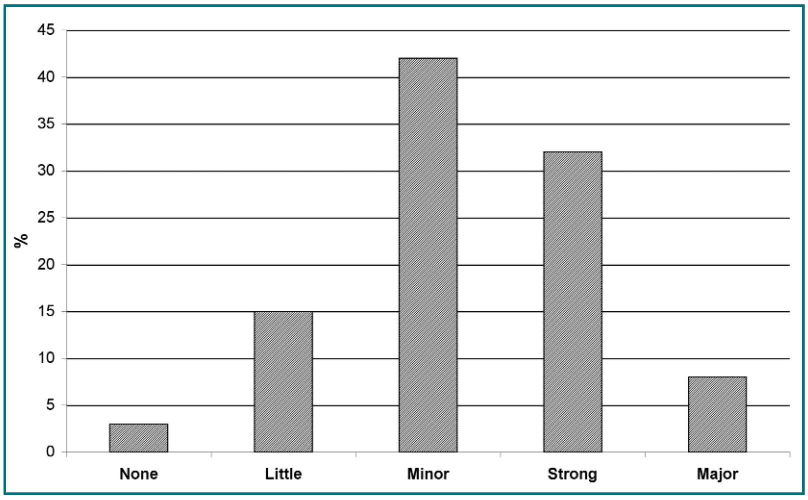

Figure 7.2 "…has the information or products had a major, strong, minor, little or no impact?' Sample Size = 300

AUSTRALIAN CRC YOUNG WATER SCIENTIST WINNER ANNOUNCED

Congratulations to Sara Lloyd who recently won the Young Water Scientist of the Year Award. Sara is a postgraduate student with the CRC for Catchment Hydrology and investigated key aspects of water sensitive urban design: its effectiveness, life cycle costs and community acceptance.

The award, worth $2500 this year, is given annually by the CRC Water Forum, an alliance of the five water-focused Australian cooperative research centres.

Congratulations also to the other award participants from the other water-based CRCs.

For further information visit http://mooki.canberra.edu.au/waterforum

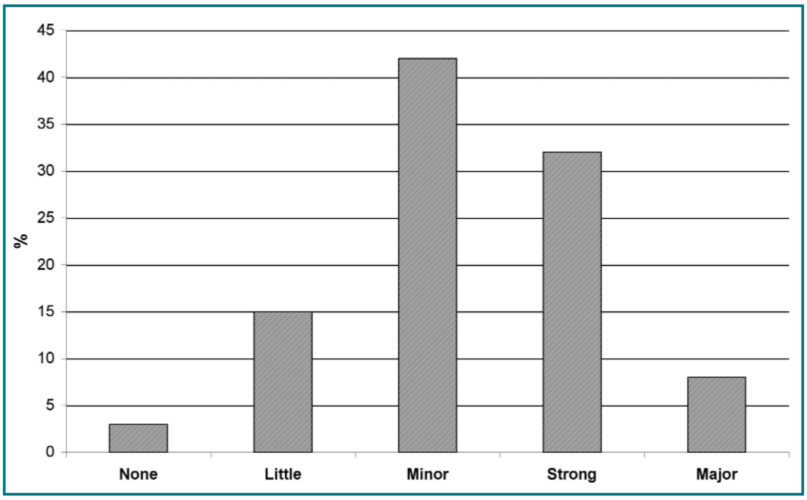

Figure 7.3 Respondents who said they intended to use CRC research in the future were asked "What do you believe may be the impact of applying that information or products…" Sample Size = 227

industry. It was encouraging that 7% visited the site at least every 1-2 weeks and this may reflect the addition of many more products to the Toolkit site over the last few months.

Overall there was a high level of satisfaction with key aspects of the Toolkit site which gives us some reassurance that the website is performing and meeting visitor's expectations (Table 7.1)

Comments or improvements

Respondents were also asked to offer suggestions for improvement or general comments about the CRC's communication. Two thirds (67%) did not offer any suggestion and the remaining one-third offered a range of suggestions. The most common was the 'desire to get more information or report electronically' (6%) followed closely by 4% who were seeking more information generally. This as a very positive sign and in response I can report that we are continuing to add information about our products, research projects and their outcomes on the CRC website.

Conclusion

The process of evaluating the external perceptions of out communication activities has been a very positive one and is an affirmation of the excellent work that our research and industry teams have completed during that last five years. Of course I can say with some confidence that the best is yet to come!

If you would like further details of the review, please contact me by email.

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Table 7.1 Satisfaction levels with features of the Toolkit website. Sample size = 178

Attribute	% "satisfied" or "very satisfied"
Speed and performance of the site	93
Ease of registering as a member	91
Ease of downloading the software	91
Ease of use and navigation	87
Extent of product information and their use	80
Ease of contacting someone for more information	77

POSTGRADUATES AND THEIR PROJECTS

Belinda Hatt

I'm fairly new to the CRC and unknown to most so I guess I should start by telling you a bit about my how I came to be here. My mum is most amused that I ended up a scientist. When I was small, the stories that I used to churn out had her convinced that I would be a creative writer of some sort. It's safe to say I definitely was not a fan of maths and science but that all changed when, towards the end of high school, I had a great science teacher and an even better maths teacher… and my future as a writer was all over.

I've always been an outdoors person so I went and got myself a degree in environmental science at RMIT University, majoring in chemistry. My honours year was spent in the Shepparton Irrigation Region, working on a pilot project trialling the use of sacrificial areas of farmland and salt tolerant trees to combat the rising saline watertable that is threatening the viability of Victoria's "foodbowl".

From there it was all chance that led me to become especially interested in stormwater. At the end of my undergrad degree, while I had some vague ideas about continuing on from my honours work, the only thing I was sure about was that I DIDN'T want to work in analytical chemistry. And my first job? Yep, you guessed it, I was an analytical chemist. Hmmm…

My first job was with the Water Studies Centre here at Monash University, working as a research assistant on a CRC for Freshwater Ecology project investigating the effects of urbanisation on the ecological function of streams. Tim Fletcher was also involved in that project and it was through him that I came to hear about the CRC for Catchment Hydrology and some of the work the urban stormwater program was doing. From there came discussions regarding possible postgraduate study, which initially led to a six month stint as a research assistant in the Department of Civil Engineering, compiling an inventory of current Australian stormwater recycling practices. One of the key lessons to come out of that review: there is a paucity of technologies that can reliably and affordably treat urban runoff to a standard suitable for recycling, and this is one of the major reasons holding back widespread implementation of stormwater recycling.

So here I am. Six months into my postgrad studies at Monash, supervised by Ana Deletic and Tim Fletcher. I'm working on developing novel biofiltration systems that will treat stormwater to a level fit for recycling. Biofilters are structural stormwater controls that collect and detain stormwater using vegetation and a filter media. They are constructed as vegetated buffers on top of a soil, sand, or gravel filtration medium in shallow basins or landscaped areas. Stormwater flows over the vegetation and slowly seeps through the filter – pollutant removal is achieved as a result of enhanced sedimentation in the vegetated zone, filtration, adsorption and other processes in the filter media, and plant and biofilm uptake of pollutants. An underdrain collects the treated water, while some water infiltrates into the surrounding soil. Biofilters work best in small catchments (up to ~2ha) and thus offer an alternative on-site method for collection and treatment of stormwater.

Conventional biofilter design is currently not tailored to reliably treat stormwater to the high standards required for water use. Recommended pollutant removal rates for urban runoff (which are, for example are 80, 45 and 45% of the average annual loads of Total Suspended Solids, Total Nitrogen and Total Phosphorus - Victorian Stormwater Committee, 1999), are for stormwater that is to be released to downstream waterways. Pollutant removal needs to be consistently higher if water is to be recycled for human use, even if the end use is non-contact.

My research is/will involve trialling different types of filter media (e.g. peat, vermiculite, wood chips) in both the laboratory and the field. I am currently building one-dimensional (vertical) flow infiltration columns in the lab, which I will use to trial possible filter media under varied flow rates, pollutant concentrations and stormwater detention times, before moving onto building horizontal flow biofilters (still at lab scale) which will also incorporate a vegetated zone and operate over a longer time frame. The results from the one-dimensional columns will inform my choice of filter media for further investigation in the horizontal flow biofilters. We are also in the process of designing a biofilter that we hope to build on campus. This system will collect and treat runoff from an adjacent carpark, which will then be stored in a nearby pond and finally used to irrigate Monash's sports ovals. Yep, a field site on campus, it doesn't get much better than that!

Further down the track, my work will move onto modeling, looking at how biofilters fit into the bigger picture of integrated urban water management. With any luck I'll end up coming up with some useful design guidelines for reliable (both in terms of treatment efficiency and lifespan) and economical biofilters.

Reference

Victorian Stormwater Committee. (1999). Urban stormwater: best practice environmental management guidelines. Melbourne: CSIRO Publishing.

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PUBLICATION ERRATA

Hydrological Recipes - Estimation Techniques in Australian Hydrology

It is now eight years since Hydrological Recipes: Estimation Techniques in Australian Hydrology was published by the CRC for Catchment Hydrology and over 690 copies have been sold.

During that time users were requested to contact us with feedback and ideas for new topics. While no new topics have been suggested, several errors have been identified.

The Errata document is available as an Adobe Acrobat PDF file from the CRC web site at www.catchment.crc.org.au /news

The CRC welcomes notification of any other errors that users are aware of.
Please contact David Perry on 03 9905 2704 or email david.perry@eng.monash.edu.au

CRC PROFILE

Our CRC Profile for September is:

Fiona Chandler

Never a dull moment!

I always sprouted that I would never work in a city (some may debate whether Brisbane is indeed a city…). yet here I find myself for the ninth year working for Brisbane City Council. There's never a dull moment working in Australia with the largest local government authority in the world especially with its 6,500 employees, 900,000 residents, 38 creek catchments, more than 7,000 km of waterway and our fair share of concrete.

Over the last five years I have been responsible for managing and optimistically attempting to improve the ecological health of Brisbane's waterways with the Council's Water Resources Branch. Much of my own personal energy is credited to working with the likes of Barry Ball, André Taylor and Tony Weber. With their leadership and passion, how could I not want to take on the world. (Tony, thank you for leaving me with the challenge of maintaining nearly 1,000 stormwater quality improvement devices…..)

Speaking of wanting to take on the world, I have recently been seconded to the Moreton Bay Waterways and Catchments Partnership (the long name study) to lead the development and implementation of a Strategy for Water Sensitive Design in South East Queensland. The phrase 'herding iguanas' has been mentioned more than once by others in conversation - however there have to be some bonuses to following in the footsteps of the rest of Australia in the adoption of water sensitive urban design – don't there?

Although I have moved across the road, I maintain my interest and role in supporting Brisbane City Council optimise the value of the CRC for Catchment Hydrology and eWater CRC in south-east Queensland (and reminding you all that the weather is much nicer in Queensland).

Didn't everyone go scuba diving after school?

My passion for the marine environment was established at an early age – growing up in Bowen, North Queensland meant I was my father's fishing partner, boat driver and dive buddy. 20 years later I now realise how lucky I was to grow up with the Great Barrier Reef and Whitsunday Islands on my door step, and how wrong I was in thinking every child went scuba diving after school, ate fresh seafood five times a week, and gorged themselves silly on mangoes at Christmas.

From this you have no doubt gathered that on weekends I am most likely to be found in Moreton Bay some 30m below sea level. In my spare time I work as a dive master and absolutely love watching the smiles on peoples faces when they first discover what lies under the blue, wet stuff. Moreton Bay is blessed with warm water, coral reef, whales, dugong, turtles and great beaches. This, combined with the lengthy sojourns to Central America and Papua New Guinea, makes life almost bearable.

Back to the real world…

Not wanting to go to University in the big smoke… I settled on a relatively new undergraduate course offered through the University of Queensland's Gatton Campus. In four years, the Bachelor of Applied Science in Natural Systems and Wildlife Management introduced me to more aspects of managing our natural assets than Victorians moving to south-east Queensland. Rural land management, coastal management, cultural management, marine park management, pest management, recreation management, catchment management, fire management, engineering, chemistry, planning, microbiology, marine biology, population ecology, botany, psychology, sociology, surveying, landscaping, problem solving, ……. you could never have convinced me ten years ago that each of these areas fundamentally affect how our natural and particularly our catchments are managed. This complexity and diversity keeps me motivated and intrigued. Consequently I now find myself launching, albeit with trepidation, into a Masters in Natural Resource Studies, also with the University of Queensland.

So I give you all plenty of warning, I may be knocking on your door soon, with another pesky survey to be filled out on water sensitive urban design.

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WHERE ARE THEY NOW?

Report by Cuan Petheram

How I managed to board that flight I still don't know. With the blessing of my supervisors Glen Walker, Rodger Grayson and Mirko Stauffacher I had submitted my thesis (Development of a regional scale salinity risk method using a catchment classification) and was bound for Vancouver, Canada for a six-month North American rock-climbing, kayaking and mountaineering road trip. Prior to boarding the flight I managed to cover several security guards with fine white dust when they ripped my climbing rack and chalk bag out of my carry-on bag. I also managed to send the security guard by the security scanner into a state of panic when she noticed that I had something strapped to my chest (I was wearing a life jacket under my many layers of clothing – hey not everything would fit in my luggage). In the anthrax-anxious world of post 11th of September it took all my charm to get through that crisis and get them to re-open the doors of the aeroplane.

Upon arriving in Vancouver I met up with Dale, a Melbourne climbing friend and within the week we had purchased a 1986 Dodge caravan (i.e. the classic North American 'soccer mom' car) complete with fake wood panelling along both sides. We christened it 'Clyde' (as in Clydesdale horse), loaded up all our toys and junk and together with an unreliable butane powered portable stove called Pete (named after a temperamental mutual friend of ours) we travelled down the length of the west coast of North America in search of adventure and cheap food to cook. Highlights were the Northern Cascades (Washington State), Yosemite (California), Paradise Forks (Arizona), Baja California del Sur (Mexico) and clocking up our 500th Peanut Butter and Jelly sandwich milestone. Low-lights would have been when Clyde had to be ditched when he fatally broke down 100 km short of our return to Vancouver, losing tic-tack-toe to a chicken in Los Vegas and falling tantalisingly short of 1000 Peanut Butter and Jelly sandwiches for the trip.

On returning to Australia I came back to earth with an almighty thud. I had no money, no job and no PhD (I still had a few corrections to do to my thesis). In my absence my girlfriend had also moved back to her home-town of Hobart. Despite Tasmania having 12% of Australia's runoff (with only 1% of the area and 3% of the population), there were no hydrology jobs going in Hobart so I ended up joining Hydro Tasmania as a wind energy consultant. Within a year of living in Hobart, I started to feel like a local: I knew many of the trails on Mt Wellington; I'd started calling the rest of Australia the "big island" and; stickers with environmental messages started to appear on my car.

Alas it wasn't to be. As much as I loved life in Hobart (and enjoyed my job as a wind engineer), I decided that I needed to get back to my hydrological roots. So when a vacancy for a hydrologist at CSIRO in Townsville arose I jumped at the opportunity to get involved in one of the frontiers of hydrological research in Australia: tropical hydrology. To me this was an exciting opportunity because tropical hydrological systems have some unique features. They are highly dominated by extremes (e.g. rainfall associated with cyclonic activity), the rates of key processes are very rapid, and (despite 40% of Australia lying in the Tropics) the region is relatively 'undeveloped'. Thus opportunities exist to examine hydrological systems before development takes place, and to make recommendations to avert environmental degradation before it happens, rather than trying to patch up after the event, as has occurred in many other parts of Australia.

So, I packed up my home and sweet-talked my girlfriend into moving from one end of Australia to the other – just so I could rejoin CSIRO! My initial project is to ascertain the cause of a particularly prominent groundwater mound in the Burdekin River Irrigation Area (BRIA) of the Lower Burdekin. For those not familiar with North Queensland, the Lower Burdekin is situated about 90km southeast of Townsville and is one of Australia's premier irrigation districts with 80,000 ha (and expanding) of irrigated sugarcane and smaller areas of horticultural crops. The region receives the highest number of sunlight hours in Australia and is underlain by a highly transmissive aquifer system which the locals refer to as 'liquid gold'. As a result of these factors the Lower Burdekin produces some of the countries highest quality and greatest quantity of sugarcane per hectare.

So while my official association with the CRC for Catchment Hydrology has ended I try to keep abreast of all that's going on through *Catchword*, the CRC for Catchment Hydrology website, and the ever reliable grapevine. I wish you all the best with the 'eWater' bid.

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CATCHMENT HYDROLOGY

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

Associates:
Water Corporation of Western Australia

Research Affiliates:
Australian National University
National Institute of Water and Atmospheric Research, New Zealand
Sustainable Water Resources Research Centre, Republic of Korea
University of New South Wales

Industry Affiliates:
Earth Tech
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