NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 118 JULY 2003

A NOTE FROM THE DIRECTOR

Professor Rob Vertessy

Inside...

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

BEYOND 2005 – TOWARDS A NEW CRC

The CRC for Catchment Hydrology has just completed its eleventh year of operation and has just passed the four-year mark in its current round of funding. Although we are presently funded for another three years, the cycle of Commonwealth CRC Program funding is such that we will need to submit a re-bid within a year from now. If that bid is successful, our final year of funding would be truncated to make way for a new CRC to start in July, 2005. As it happens, the Commonwealth guidelines for the next round of CRC funding (Round 9) are yet to be released, but we fully expect that a call for proposals will be made later this year with a request for bid submissions by around May 2004. At its 30 May 2003 meeting, the Governing Board of our CRC decided to proceed with the formulation of a re-bid. Encouragingly, all of our current Parties have declared an interest in participating in the preparation of a re-bid. Naturally, their ultimate involvement will depend on the portfolio of research that the successor CRC proposes to tackle.

Which brings us to the question ... what would a successor Centre to our current CRC look like? Well it is too early to answer that question, but a process is now underway to resolve it. Our first step has been to form a re-bid strategy group that will explore different options for a successor CRC and make recommendations to the Governing Board. However, the re-bid strategy group won't be jumping to too many conclusions yet because we first need to hear from the land and water management industry. As we have done in the past, we will soon be convening a national workshop to discuss the priority issues in catchment management and a research agenda to tackle them. All of our current Board members will gather in Brisbane on 28 August 2003, along with senior representatives from several other organisations to work through a structured program aimed at setting a 'big picture' research agenda for a successor CRC. Now, more than ever, it is vital to listen to the land and water management industry and craft a research agenda tailored to the management questions of the future. Why? Because land and water issues are getting unprecedented public and political attention at the moment and it is the duty of the research and development sector to work hand-in-glove with the land and water management industry to 'get it right'.

Whilst nothing has been set in stone yet, the Board has articulated a few ideas regarding where it wants a successor CRC to move towards. First, there is a desire to have more of a national coverage, particularly in Western Australia, South Australia and possibly far north Queensland. Secondly, we feel that our focus on predictive modelling is sound and should be maintained. Thirdly, we feel it is essential to focus even more heavily on integration, particularly in coupling economics and ecology to catchment hydrology. Fourthly, we want to work even closer with other CRCs, particularly Freshwater Ecology and Coastal Zone who are also preparing re-bids for the next round of funding. Our three CRCs have agreed to work together to ensure that our re-bids are closely linked. Finally, we have identified the need to link to other major land and water R&D initiatives, particularly the Healthy Country Flagship Program being led by CSIRO and Land and Water Australia.

For the next few months our CRC is in listening mode. I'm eager to hear from anyone who would like to state a view of where a successor CRC to our current Centre should head. If you feel your organisation would benefit from involvement in our CRC, please let me know. There are a number of ways for organisations to participate in our CRC, including full Party, Associate, Research Affiliate and Industry Affiliate membership.

Although we have entered re-bid mode, we won't be slackening the pace in our current CRC, nor diverting our attention from our present operational plan. The last year has been the busiest of our eleven-year history. We expect the next year to be just as busy and even more productive as industry starts reaping the benefits of the Catchment Modelling Toolkit and Development Project initiatives. We set out to revolutionalise catchment prediction in Australia and I believe we are well on track to achieving this within the life of this CRC.

Rob Vertessy
Tel: (02) 6246 5790
Email: rob.vertessy@csiro.au

CRC PUBLICATIONS LIST

This month's issue of Catchword includes a Publications List that provides updated details of CRC documents and products available through the Centre Office.

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

Centre Office
CRC for Catchment Hydrology
Department of Civil Engineering
Building 60
Monash University Vic 3800
tel: 03 9905 2704
fax: 03 9905 5033
email: crcch@eng.monash.edu.au

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Report by Geoff Podger, Nick Murray and Harold Hotham

Support processes within the Catchment Modelling Toolkit

Whether it's underwear or software, nothing is as important as good support. In order to support the growing number of products and developers using the Catchment Modelling Toolkit, the Toolkit team has developed and adopted a number of instruments that:

- make the Toolkit products easier to develop and maintain
- make the Toolkit products easier to use and manage

This article describes some of these instruments.

What does "support" mean?

How support is perceived really depends upon what level you are involved in the use or development of CRC for Catchment Hydrology products. Different levels of support are provided for product users, product managers and software developers.

- Users

  For users of Toolkit products, previous *Catchword* articles have discussed the support provided by the Toolkit web site such as software upgrades, documentation, lists of associated papers, user forums and email. There is also support in the training courses and workshops that are provided for particular products or model developers.

- Product managers

  Product managers have a much more demanding task in ensuring that products meet certain standards and that documentation is provided. They also need to support the product which involves managing bugs, enhancements and training. The CRC for Catchment Hydrology provides support for product managers such as a web site that handles the distribution of the product and deals with communicating with product users. Procedures are also provided to guide product managers through the steps to create a product that can be released via the Toolkit web site (www.toolkit.net.au). Documentation examples and templates are also provided to assist with writing documentation and providing on-line help.

- Developers

  Software developers also require support, and this is provided by training workshops. The TIME software environment supports model developers by allowing them to rapidly prototype products without worrying about the overheads of developing user interfaces. In addition, TIME offers a range of common services and functions that support developers who wish to value add to a product. An example is reading time series files: developers don't need to worry about writing software to read the multitude of different file formats as TIME already provides this capability. A further bonus is that if a developer chooses to add a new file format (or any other feature) to the TIME framework, this can easily be promulgated across all TIME-based products, simply by recompiling them. A version control system has been put in place that allows developers to develop software across the web.

The remainder of this article discusses a few of the processes, standards and tools that the Toolkit team currently use in order to make the Toolkit products "supportable".

The toolkit 12-step product induction plan

Before a product is accepted into the Toolkit, it must pass through the 12-step Toolkit Induction Plan. Apart from acting as a checklist of quality control processes, this plan provides guidance to product managers on what is required to develop a product. Toolkit product managers have an important role in managing:

- fault-reporting and fault-fixing
- the efficient development of products using modern software engineering practices
- documentation
- the production of training material and coordination of training courses

It is important to realise that that the Toolkit products are just that - products - and that users of the products will expect a certain level of assistance and this is provided by courses, documentation, other users and product managers.

Standards

In order to make it easier for users to work with different Toolkit products, the Toolkit team are developing a documentation standard and a user interface standard. Both standards are close to being released and are currently being trialled and tested using RAP, SEDNET and the Rainfall Runoff Library.

The documentation standard defines a set of standard documents that must be provided with each Toolkit product. These documents include a user/reference guide, an online help system and workshop materials/tutorials. The standard also specifies the form of the documents and there is an associated MS-Word template with a pre-defined structure and styles to make writing the documents much easier.

These "standard" documents, along with the software product itself, form part of the "product interface" to the user: when users think of a product, they should feel confident that the product has the same level of documentation as other Toolkit products. Providing good documentation up-front should reduce the need for support calls to product managers or developers.

The user interface standard is also a preventative measure: by making the operation of the Toolkit products as consistent as possible (and this is a long term goal), then once a user knows how to load and run a model in one product, the process should be similar in other products. Of course, each product has a different emphasis so there will always be some differences in operation.

CVS

The Concurrent Versioning System (CVS), is a tool that supports developers by allowing them to work together on shared code in a productive and organised way. The most important function of CVS for developers is that of version control. Version control allows developers to work on a piece of software code, save it to a database, and give it an identifying number. They can then change the code, and if necessary roll back to a previous version. This "repository" of code also means that all developers have access to the latest version of the Toolkit framework.

Testing

Testing is an essential part of producing reliable and robust software as it ensures that the code libraries used by model developers are functioning correctly. Currently there are a number of programmers working on code development at any time and it is easy for the existing functionality of a particular piece of code or library to be inadvertently changed. By running special types of tests, called unit tests, we can minimise the chance of this happening. Unit testing is best suited to code libraries rather than models, since they work by calling a function with a known input and comparing the output of the library with an expected value. If the code does not produce the expected value, the test fails and the programmer is alerted to correct the problem. Unit tests are attractive for large-scale testing since they can be run in batches to test entire sections of code. They allow us to ensure the integrity of modules contained within the Toolkit framework.

In summary

The Toolkit team aim to reduce the amount of support needed by products after they are delivered by adopting development practices that make it easier to change and quality-control software code, and by promoting standards that give users a consistent and easy-to-use experience across the Toolkit products and documentation. By promoting the TIME framework, the Toolkit team allows model developers to focus on modelling and not be distracted by software development issues. The Toolkit website (www.toolkit.net.au) provides information on planned Toolkit products and training events, and supports users and model developers with a range of email lists and product information pages.

Geoff Podger
Tel: (02) 9895 7480
Email: gpodger@dlwc.nsw.gov.au

Nick Murray
Tel: (02) 6246 5723
Email: nick.murray@csiro.au

Harold Hotham
Tel: (02) 6246 5847
Email: Harold.hotham@csiro.au

www.toolkit.net.au

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

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

For further information visit www.toolkit.net.au

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

CRC PROJECT PORTFOLIO (2003-2005)

The CRC has published a 'Project Portfolio' which gives readers an overview of the CRC, its mission and short summaries of all new CRC projects (2003-2005).

Copies can be obtained from the Centre Office by contacting Virginia Verrelli on 03 9905 2704.

The document can also be downloaded as an Adobe Acrobat .pdf file from our website at www.catchment.crc.org.au/news

For further information please contact David Perry on 03 9905 9600.

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Ian Prosser

Project 2.13: Mapping of sediment and nutrient exports across the Murray-Darling Basin

Background

A team of researchers from CSIRO Land and Water and the ICAM Centre at ANU (Integrated Catchment Assessment and Management) have just completed a three year CRC for Catchment Hydrology Associated/Additional project for the MDBC, mapping erosion and resultant river sediment loads across the whole of the Murray-Darling Basin. The project was led by Chris Moran with contributions from Greg Cannon, Barry Croke, Ronald DeRose, Andrew Hughes, Tony Jakeman, Hua Lu, Lachlan Newham, Jon Olley, Ian Prosser, Anthony Scott and Martin Weisse.

This project undertook a major synthesis of existing information on sediment and nutrient transport across the Murray-Darling Basin, used spatial modelling to quantify the patterns and rates of current sediment and nutrient transport, and developed methods to most effectively target sources of sediment and nutrient in future land management. Those methods also quantify the benefits gained from different investment scenarios.

Erosion history for Murray-Darling Basin

The history work has been published as a booklet for wide dissemination across the Basin. It showed that the Basin has been subjected to several phases of erosion and that much of that sediment remains in rivers, which together with other changes to river form continues to degrade aquatic habitat. Much of the erosion may now have waned but in areas of the Basin that are still being developed there are opportunities to prevent history from repeating itself.

Modelling of sediment and nutrient budgets

The spatial modelling of sediment and nutrient budgets further developed techniques that were first applied to the Basin in the National Land and Water Resources Audit. These techniques use all available information, including spatial data and river gauging data to predict the sources of sediment and nutrient. The material is then routed through the river network, accounting for losses to deposition and nutrient transformations, to produce predictions of mean annual load in each river link (the SedNet model). An advantage of the techniques is that sediment and nutrient sources that contribute to downstream loads can be distinguished from those that have only local impact. Such information is valued by catchment managers who are trying to improve water quality through targeted land management.

Improvements to sediment predictions

This project made improvements to the budget techniques including a new technique to estimate hillslope sediment delivery ratio, better estimation of hydrological parameters, inputs of higher resolution land use mapping, inclusion of anabranches and new assessments of gully and riverbank erosion. This resulted in sediment predictions (per unit area) which match observed loads in the southern part of the Basin to within 20% with one exception. Nutrient budget accuracy was not as good because of poor input data on nutrient concentrations and an insufficient understanding of in-stream transformations at the basin scale. To our knowledge the sediment predictions are considerably better than any other predictions undertaken at this scale.

Sediment and nutrient results

The results show that approximately 60% of river length has sediment and nutrient loads in excess of 20 times the natural load, and 20% have deposits of sand that degrade bed habitat. The sources of this material are variable. Soil erosion dominates in the northern parts of the Basin, while upland areas of NSW and Victoria are dominated by gully and riverbank erosion. Similar results are found for P but in the southern parts of the Basin N sources are dominate by dissolved forms in runoff. A key result of the budgets is that typically in the river basin 50-80% of the material exported to the end of valley is derived from just 20% of catchment area.

Identifying investment priorities

We developed techniques to set priorities for future land management, using the budget results. The primary aim was to develop methods that can inform judgments relating to the most cost effective means of controlling suspended sediment loads. The methods identify priority management areas and show water quality benefits downstream for different levels of investment and different investment strategies, through estimates of restoration costs. The results show that effective targeting of restoration can reduce the restoration cost by many times. Investment which targets contributing sources is much more efficient than targeting erosion *per se*, or arbitrary investment. A generic algorithm was demonstrated to produce the same results as the optimal sediment model. This approach can be applied to more complex problems such as achieving multiple management objectives for which there is no simple optimal solution.

Ian Prosser
Tel: (02) 6246 5830
Email: ian.prosser@csiro.au

PROGRAM 3
SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Hector Malano & Wijedasa Hewa Alankarage

Integrating trading into water allocation and economic modelling for the Goulburn-Broken catchment

A substantial amount of effort has been invested in Project 3.1: 'Integraton of water balance, climatic and economic models' and Project 3A: 'Hydrologic and economic modelling for water allocation' to integrate water allocation network models and economic models. The main aim of this effort is to develop appropriate tools to evaluate the economic impacts of alternative water allocation policies.

Water trading has been growing in importance in the Goulburn-Broken catchment in the last few years with permanent and temporary water trading accounting for approximately 1% and 10% of overall water use in the catchment respectively. It is therefore vital to develop an effective modelling capability to describe the dynamics of trading and its integration into the overall water allocation-economic modelling framework. Such a framework is necessary to quantify potential environmental and regional socio-economic impacts of water trading.

The main challenge to achieve this objective is the ability to accurately simulate water trading. Associated/Additional Project 3.6: 'Water trading and its implications on system management and environmental flow: The case of the Goulburn-Murray Irrigation Scheme' has focussed on evaluating the potential impacts of water trading on streamflows and environmental flows in northern Victoria. To achieve this aim, it developed a modelling framework based on the integration of a water transfer model with the Goulburn Simulation Model (GSM) currently used by the water authorities in Victoria to determine water allocation policy.

Modelling framework

Modelling water demand and trading is a complex task. Water trading responds to a number of variables including profit maximisation, risk taking behaviour of traders, and alternative options available to users such as substitution of stock feed. The most common approach to modelling trading and resource transfer has been through the use of various optimisation techniques such as Linear Programming (LP) and Dynamic Programming (DP) which assume profit maximisation behaviour by water traders.

The approach taken by this project is based on the transfer of water between water demand centres included in the GSM[1] model. In this approach, water moves from demand centres with surplus allocation to demand centres with deficit allocation.

The modelling algorithm begins by computing the basic water demand from irrigation centres using the Program for Regional Demand Estimation (PRIDE) currently in use by the Government water authorities in Victoria. The model outputs constitute the potential water demand from irrigation areas and private diverters based on cropping areas existing in the 1993/94 water year as established by current MDBC Cap regulations.

The GSM model is then applied to determine seasonal allocations taking into account resource availability, storage volumes and conveyance capacity constraints within the system to meet the potential demand from each demand centre. Demand centres are sub-centres within an irrigation centre or district. The initial assessment of potential demands and allocations is then used together with the existing permanent water entitlements to determine the surplus or deficit associated with each demand centre.

Water demand and water trading

Water availability, surplus or deficit, within an irrigation centre is calculated in the model on the basis of three farm types - horticulture, dairy, and cropping and grazing - and depends on available permanent water entitlements and seasonal allocations. Allocation of available water to each farm type in the model for a particular month follows the relative priority of crops. For example, within dairy farming, a higher priority is assigned in decreasing order to perennial pasture, lucerne and annual pasture. Surplus or shortage for each farm type depends on the monthly crop water requirement and available water. These are then aggregated to determine the monthly surplus or shortage for an irrigation centre. Crop priority together with price-demand relationships for water trade were determined early in the project by a survey of water traders.

Water shortages in each centre are satisfied by trading water from irrigation centres with water surplus to those with water deficit, based on the following set of rules:

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

CRC SHORT COURSE

Design of Rock Chutes for Stream Bed Stabilisation

15 August 2003
City venue, Melbourne

This CRC short course targets professional engineers and managers involved in stream rehabilitation and restoration.

Presented by:
Assoc. Prof. Bob Keller (CRC)
Dr Tony Ladson (CRC)
Frank Winston (CRC)
Dr. John Tilleard (Earth Tech)
Ross Hardy (Earth Tech)

Registration for the Workshop costs $330 and places are limited to 40 participants.

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

OTHER OUTLETS FOR CRC PUBLICATIONS

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

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

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

- Water moves along the existing trading routes allowed by the water authority for temporary water transfers between demand centres,
- The volume of trade responds to the price-demand relations for water trade for the different farming enterprises including dairy (perennial pasture), dairy (annual pasture) and cropping and grazing.
- Horticulture has the first priority of allocation which must be fully satisfied before other crop types can access water on the temporary market.

Figure 3.1 shows the conceptual approach followed by the model to achieve an equilibrium of transfers between irrigation centres. Firstly, the volume of surplus water available for transfer is determined from the comparison between demand and actual allocation. If the surplus volume is less than the total demand deficit, the model begins the search for the equilibrium price from a low level (Points A1 & A2) increasing the price up to the level buyers in each farming type (FT) are prepared to pay for the volume of surplus water available to trade on the market (Points B1 & B2). The result indicates the aggregate volume of water that is purchased by all farming types (Point B). Otherwise, if the volume demanded is less than the surplus volume available, the appropriate equilibrium price is selected between points A and B.

The model was calibrated against water trading data obtained through a survey questionnaire conducted during the water year 1999/00 by adjusting the deficit-irrigation factor for each water demand centre. The model was subsequently tested against water trading data from the 1997/98 and 1998/99 water years. Figure 3.2 shows the model performance in predicting water trading for different irrigation centres for the water year 1997/98. Overall, these results are very encouraging. The model predicts trade volumes with good accuracy in most cases. The prediction is less

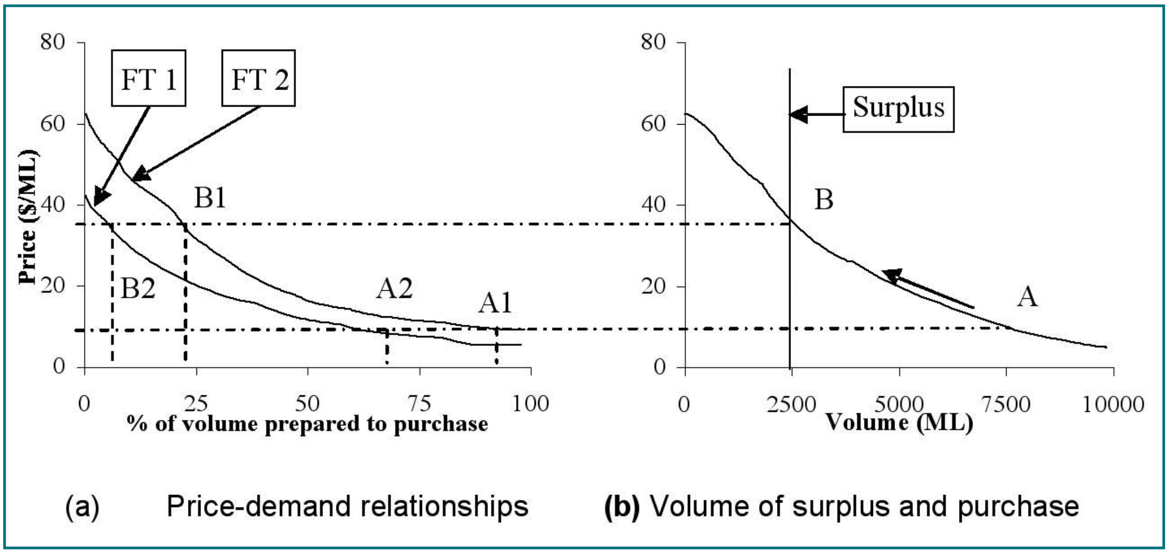

Figure 3.1 Schematics of water price equilibrium used in the water transfer model.

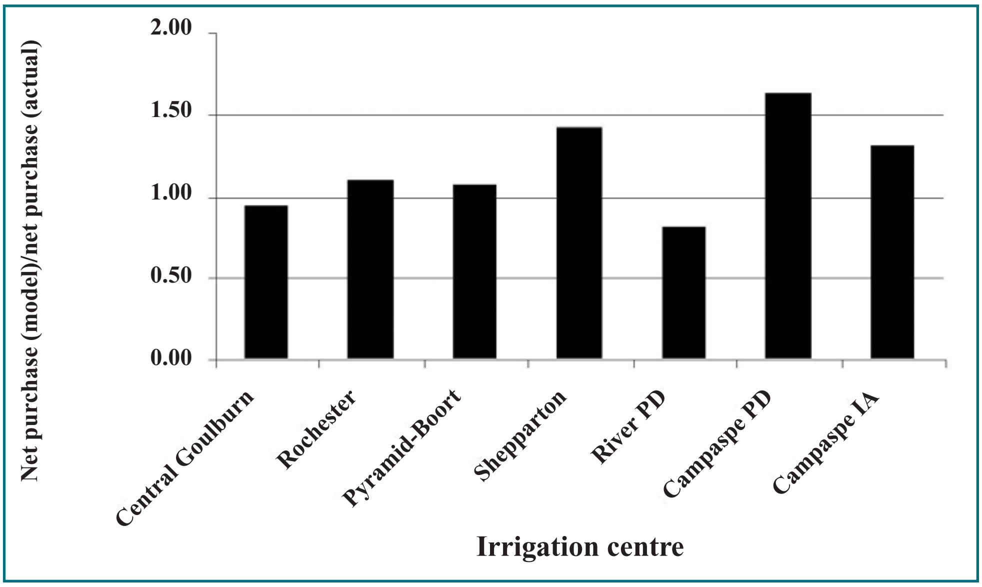

Figure 3.2 Comparison of predicted vs. observed water trading for Victorian demand centres.

accurate for Shepparton and Campaspe PD irrigation centres. This would suggest that the water-pricing equilibrium is capable of explaining a greater proportion of traders' behaviour in some districts than others; other factors may play a more important role in traders' decisions in such cases.

Water trading modelling in progress

It is recognised that there are various factors in water trading that are not described in this model and yet may have an important influence on water traders' behaviour including risk-taking behaviour, and the effect of substitute farm input prices (stock feed). Two water trading modelling efforts are currently underway with the aim of improving the current water trading prediction capability.

Azif Zaman, a CRC PhD candidate, is conducting research into the use of econometric modelling of water trading. Azif's model will incorporate several factors such as residual water availability, commodity prices, water price, and stock feed substitutes that are likely to improve the prediction of water trading under a wider variety of market conditions. This model will be dynamically linked with GSM. This research will also attempt to use these variable to improve our ability to predict future water trading.

Erwin Weinmann and his team at Monash University are also simulating irrigator response to variations in seasonal water availability/allocation (including temporary water trading) through the integration of the Regional LP and Spatial Equilibrium Models developed by DPI-Victoria with GSM to balance trade between nodes for the season subject to the regulatory constraints currently applied. Unlike Project 3.6 where the price-demand curves were developed from farmers' survey data, in this approach the price-demand curves developed for each node are derived by economic optimisation modelling based on the mix of farm enterprises at each irrigation node. This allows a broad range of future land use and water allocation scenarios to be investigated. By deriving different sets of price-demand curves for different seasonal conditions, the method will also allow the influence of climate variability to be more closely examined. A detailed outline of this approach is provided in the May edition of *Catchword* (116).

Hector Malano
Tel: (03) 8344 6645
Email: hectormm@unimelb.edu.au

Wijedasa Hewa Alankarage
Tel: (03) 9974 4646
Email: wijea@srw.com.au

WEATHER RADAR CONFERENCE

Sixth International Symposium on Hydrological Applications of Weather Radar

2-4 February 2004
Melbourne, Australia

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

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

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

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - An Overview of their Use, Value, Cost and Evaluation

By
André Taylor
Tony Wong

Technical Report 02/11

This report presents an overview of a CRC project co-funded by EPA Victoria that investigated the use, value, life-cycle costs and evaluation of non-structural best management practices (BMPs) for improved urban stormwater quality and waterway health.

The report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

PROGRAM 4
URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Catherine Rossignoli and Ana Deletic

Victorian Stormwater Database

Introduction

The pollution carried in stormwater runoff degrades aquatic environments. This is becoming a significant problem in populated areas where a major portion of pollution is attributed to stormwater runoff (Somes and Wong, 1994; Allison *et al.*, 1998). The pollutants entering the system include gross litter, sediment, metals, nutrients, oil, garden & agricultural chemicals, and chemical spills (both inorganic and organic). The diffused and variable nature of the contributing pollution sources causes serious problems when developing stormwater management strategies.

Compounding this problem in Victoria is the lack of quantitative data concerning pollutant levels, pollutant transport and the effectiveness of different treatment alternatives in trapping pollutants within the engineered drainage network (Allison *et al.*, 1994; Allison and Chiew, 1995; Allison *et al.*, 1996). However, over recent years a number of relevant research projects have been carried out in Australia and as a result, data sets have been accumulated. These data sets cover sites such as Blackburn Lake (RossRakesh *et al.*, 1999) and Coburg (Allison *et al.*, 1998), and a lot of other data sets collected in several CRC for Catchment Hydrology and other research projects. At present, these data are all stored in different places (usually with the person who collected them), in their own format and structured in their own style. It is usually difficult to get hold of the data and do any further analysis, including comprehensive and detailed comparison of the data of the same type. It is even difficult to know what data exists for most catchments, if any.

In July 2003, an intensive monitoring program on stormwater runoff in Melbourne was started at Monash University (sponsored by the Victoria EPA) which it is hoped will begin to fill some of the data void. During this monitoring program it is expected that several million data records will be collected at a few sites with a number of differing catchment characteristics.

The Victoria Database Project

To handle existing and future data sets, a detailed data storage application is currently being developed to store and index this large quantity of data. The database will include data on stormwater runoff but also the data on the efficiency of treatment techniques used in Water Sensitive Urban Design (WSUD). The main deliverable of this project is a new database that will contain the structure for input of data, the utilities for inspection of data, and some of the existing data gathered in Victoria. In addition, the process of the database design and defining the protocol for data input will improve the data quality control and facilitate data exchange. This will result in more efficient collaboration within the CRC for Catchment Hydrology and its participants.

The main advantage of developing a long-term centralised data store is the optimisation of the value of the data. This will occur as a result of data sets being made more uniform, and scattered sets being brought together into one central store, where efficient reporting and summary analysis can be carried out. Once complete, the application will ensure future practitioners and researchers have fast access to a comprehensive list of existing data. Because of the proposed longevity of this application, it is envisaged that data sets will accumulate over time and older sets will remain accessible in the future, thereby increasing the usage and value of existing data sets.

The Database Structure

The data application currently under development will store three types of data as described below:

1. Descriptive Data for the following:
   - Catchment;
   - Sub-catchment;
   - Treatment measures and their location;
   - Monitoring points and their location;
   - Sampling methodologies;
   - Sampling equipment;
   - Organisations;
   - People.
2. Binary Data Records – Data records from sampling programs and/or research projects which essentially consist of two parameters; namely a data/time and a data value. Runoff flow rate or pollution concentration in runoff is usually recorded in this way.
3. Array Data Records - Sometimes it is important that the relationship between individual data values is also recorded. This includes such data sets as nitrogen speciation, and data from samples taken at the top and bottom of a lake at the same in-plan location. In this case it is important that for a point in time, several values are recorded together.

Victorian Stormwater Database

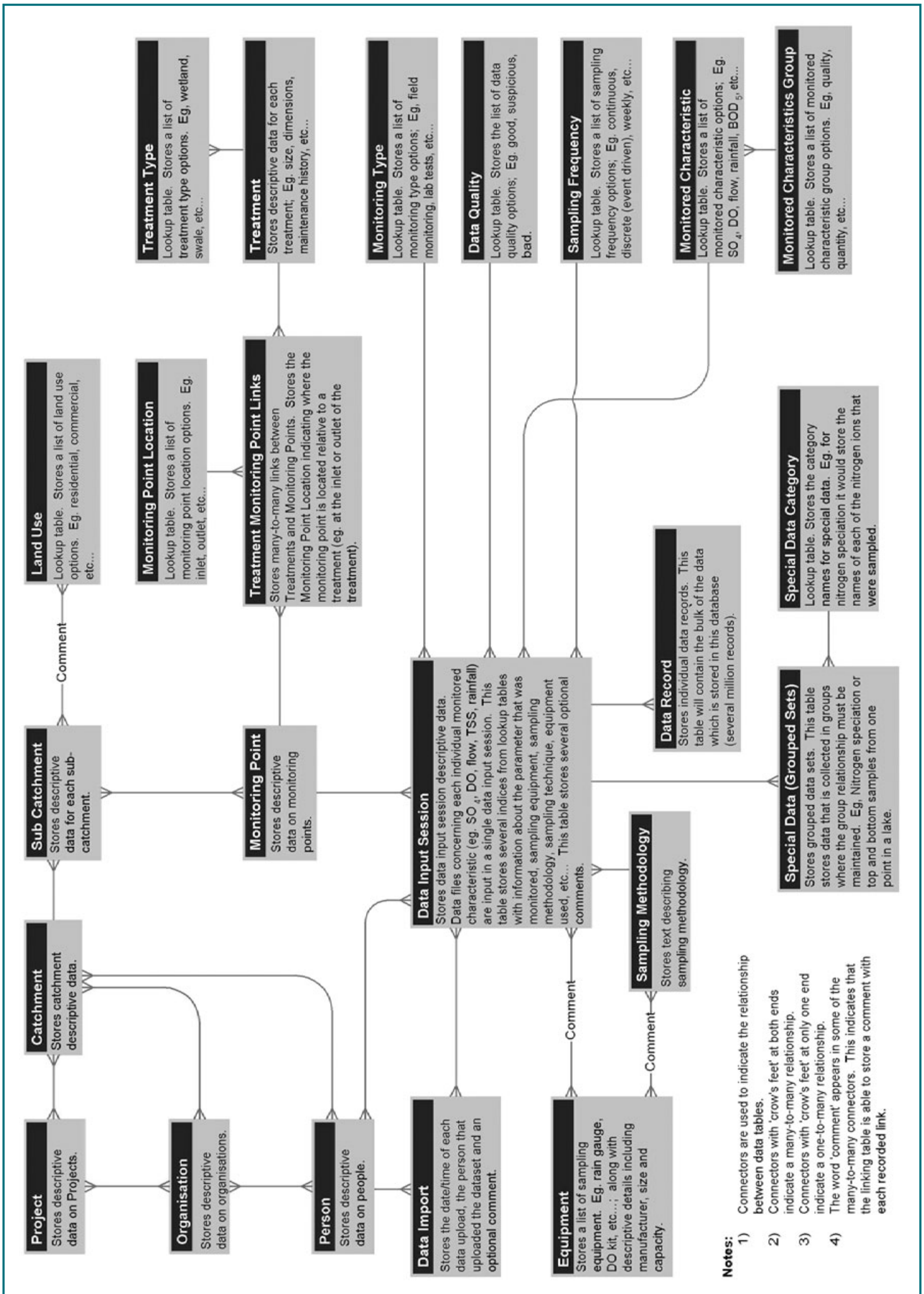

Figure 4.1 The data storage structure

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - A Survey Investigating their Use and Value

By

André Taylor
Tony Wong

Technical Report 02/12

This CRC publication is one of four reports in a series of reports on Non-structural Stormwater Quality Best Management Practices. This report documents and analyses the findings of a detailed survey of 36 Urban Stormwater Managers from Australia, New Zealand and the United States.

A printed and bound copy of the report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

Non-structural Stormwater Quality Best Management Practices - A Literature Review of their Value and Life-cycle Costs

By
André Taylor
Tony Wong

Technical Report 02/13

This CRC publication is one of four reports in a series of reports on Non-structural Stormwater Quality Best Management Practices. This report presents the findings of a literature review on the value and life-cycle costs of non-structural BMPs to improve urban stormwater quality.

A printed and bound copy of the report costs $27.50 and can be ordered through the Centre Office by contacting Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

Victorian Stormwater Database

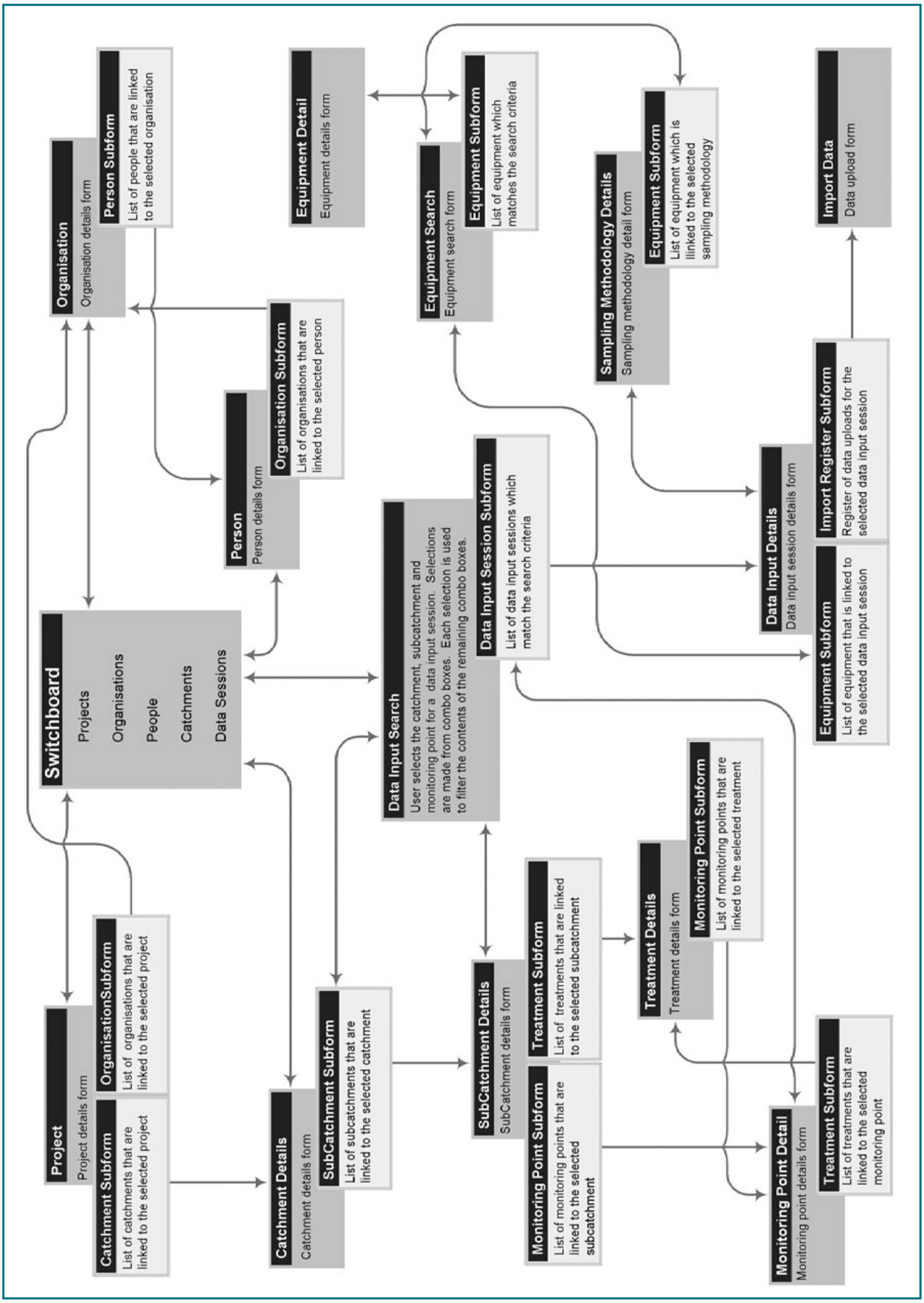

Figure 4.2 The database user interface

This application has two distinct components, one being the data store and the second being the user interface. Simplified maps of the data storage structure and user interface are included as Figures 4.1 and 4.2, respectively. This division of components has been made for the following reasons:

- To simplify the back-up of data;
- To allow other systems to access the data in the future, ie. websites, multiple users, etc…
- Data stored independently is less likely to become corrupted;
- Data stored independently is more efficient to query;
- An independent user interface is simple to update because it is small and it can be deleted and replaced without requiring data to be transferred to a new interface;

The user interface component is being developed in MS Access because of the software's ability to rapidly develop a simple and flexible user interface. The data store component is being developed using the SQL Server platform. This platform has been chosen because it is capable of storing and querying large volumes of data in an efficient manner.

File Format for Data Import and Export

Data will only be imported from, and exported to, CSV (comma separated values) formatted text documents with the file extension '.csv'. This format has been chosen in preference to MS Excel because it does not incur the file size limitations characteristic of Excel worksheets (Excel worksheets are limited to 65,536 rows). Where data sets currently exist in Excel format, they can quite simply be saved as a CSV formatted file in preparation for direct uploading into the data store application.

Project Management and Current Progress

Under the supervision of Dr. Ana Deletic, this stormwater data storage application is being developed by Catherine Rossignoli, a final year undergraduate student at the Department of Civil Engineering, Monash University. Mark Wolfe and Hammond Street Developments, professional software developers located in Nunawading, Vic (www.hsd.com.au), are also donating technical support when required. The planning and development of this application is well under way and running to schedule. It is expected that this application will be completed in late October this year.

If you have any information on stormwater data that have been gathered in Victoria (or elsewhere) please let us know! However small and uninteresting the dataset may be to you, it may be valuable when put together with other similar data.

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Catherine Rossignoli
Email: cpros1@student.monash.edu.au

Ana Deletic
Tel: (03) 9905 2940
Email: ana.deletic@eng.monash.edu.au

NATIONAL CONFERENCE ON INTEGRATED CATCHMENT MANAGEMENT (ICaM - 2003)

26-27 November 2003
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For further information about contributing papers or attending please email your query to icam2003@awa.asn.au

NEW TECHNICAL REPORT

Evaluation of Two Daily Rainfall Data Generation Models

by

Lionel Siriwardena
Ratnasingham Srikanthan
Tom McMahon

Technical Report 02/14

This report evaluates the Transition Probability Matrix model with Boughton's correction for interannual variability (TPM) and the simplified Daily and Monthly Mixed (DMMS) model for the generation of daily rainfall data. The report also compares the statistical characteristics of the daily, monthly and annual streamflow data simulated by a rainfall-runoff model using stochastic daily rainfall obtained using the TPM and DMMS models with the historical streamflow characteristics.

Printed and bound copies of this report are available from the Centre Office for $27.50 (includes GST, postage and handling).

Centre Office
tel 03 9905 2704
fax 03 9905 5033
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PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Alan Seed and Neill Bowler

An update on Stochastic Forecasts of Rainfall

Introduction

Stochastic forecasting of rainfall is a component of the "Hydrological Modelling for Weather Forecasting" project and was introduced in the November 2002 edition of *Catchword*. This article gives an update on the activities that have taken place since then.

- Applications for rainfall forecasts

Rainfall forecasts out to a lead time of at least 6 hours are required for a range of applications, particularly hydrological forecasting for flood warning. These applications require quantitative rainfall forecasts as well as an estimation of the error bounds surrounding the forecast so that they can be used to estimate the risk within the context of the particular application. For example, flood warning managers require the probability that a critical threshold in river level at a particular point on the river will be exceeded in the forecast period.

- Maintaining spatial information

Current probabilistic forecast methods assume that the major source of uncertainty in a forecast is due to errors in rainfall location due to errors in diagnosing the correct field velocity. The probability density function of forecast rainfall is simply the probability distribution of rainfall within an area that is determined by the errors in the velocity estimation. However, this approach is not able to provide the user with a probability density function of mean areal rainfall since the spatial structure of the forecast errors is not represented, and therefore will not be able to provide the information needed for hydrological applications. An alternative approach, which has not been attempted elsewhere, is to generate an ensemble of stochastic forecasts which maintain the spatial information so that distributions of areal rainfall can be calculated over areas of interest. The probability distribution of the forecast variable, river level for example, can then be calculated by routing the ensemble of forecasts through a hydrological model.

- Joint activity with Met Office (UK)

The Met Office UK Joint Centre for Hydro-Meteorological Research and the CRC for Catchment Hydrology through the Bureau of Meteorology have agreed to develop a joint stochastic forecasting engine which combines the stochastic nowcasting work with a down-scaling of NWP rainfall forecasts so as to provide a seamless set of stochastic forecast fields out to six hours. This model labours under the interim name "Stochastic Forecast Engine" on good days, and is called more colourful names on days when things are not going so well.

Research goals for stochastic forecasts

The goal is to be able to generate an ensemble of stochastic forecasts that blends the nowcast fields with NWP rainfall prediction fields into a single forecast ensemble with a maximum lead time of 6 hours, or perhaps greater. The resolution of the forecast fields is 15-minutes, 2 km over a 1024 km domain for the Met Office. The resolution and domain for the Bureau of Meteorology forecasts have yet to be decided but it is likely that the ensemble will be generated over a number of domains rather than as a national product due to limitations with the Australian radar network. The ensemble will be updated at sub-hourly intervals, depending on the speed of the host computer, but the hope is to generate a new ensemble at 15-minute intervals.

The operational implementation of the Stochastic Forecasting Engine at the two sites will differ due to differences in the operational infrastructure; the Met Office is likely to redevelop their Nimrod forecasting system and is committed to implement a prototype once their move to a new site has been completed. A decision on how to deploy the Engine in Australia has yet to be taken, but it will most likely feed data to AIFS, the operational forecasting system, via the rainfall data server which is currently under development. The joint project will develop a c++ class that will be embedded into the two operational systems.

Method – blending components

The Stochastic Forecast Engine contains three main components; NWP downscaling, nowcasting, and stochastic noise generation. The fundamental principle in the three components is that a rain field can be decomposed into a set of spectral components, and that the Lagrangian rate of temporal development is related to scale. NWP rainfall forecasts are assumed to under-represent the small scale variability that is commonly observed in rainfall fields, and therefore the NWP product is assumed to be a quantitative forecast at some scale that is larger than pixel resolution. The nowcast field also loses resolution with lead time due to the temporal development of the field between the time of the analysis and the forecast.

The major difficulty lies with combining the nowcast, NWP forecast, and stochastic noise fields in a rational manner, and in dealing with situations where the NWP forecast contains gross errors. The novel idea in this forecast engine is to decompose both the NWP forecast and current observed rainfall field into their spectral components and to blend these in a rational manner. Stochastic noise that is generated using a cascade with parameters that have been derived from the observations is used to replace the missing variability, starting from the largest scale that the model is able to represent deterministically.

Progress

- S_PROG model

  The nowcasting component of the project is essentially a development of the S-PROG model, so the initial work was to spend some time re-writing the C++ class that implements S-PROG to meet the Met Office standards and to evaluate the performance of S-PROG when nowcasting over a large domain. This resulted in some changes to the model, particularly with the field tracking components, and a much better understanding of the error characteristics of the advection estimates. Uncertainty in the field advection due to estimation errors and temporal development during the forecast period is significant for the 6-12 hour lead times and a model to generate advection fields for each member of the forecast ensemble has been developed.

- UK, Australian collaboration

  As part of the collaboration, Alan Seed spent two weeks in April 2003 visiting the Joint Centre for Hydro-Meteorology, which is at the CEH in Wallingford, to develop the basic science plan further in the light of the progress that we have made. Neill Bowler then visited the Bureau of Meteorology for two weeks in May to continue the development of a common C++ class for the nowcasting component of the project and to complete the evaluation of the field tracking algorithm.

- Current objective

  The current objective is to develop a deeper understanding of the error characteristics of the NWP forecasts as a function of scale and lead-time. The accuracy of the NWP forecast increases as a function of scale and we are finding that the Met Office NWP forecasts have limited quantitative skill below 64 km, so this is likely to be the scale at which we blend the nowcast with the forecast. We are also investigating if it is possible to use the current radar rainfall field to correct the NWP forecast in real-time, essentially looking at the bias in the forecast as a function of lead-time by comparing the NWP and radar rainfall fields that have both been smoothed to 64 km resolution.

Alan Seed
Tel: (03) 9669 4591
Email: a.seed@bom.gov.au

Neill Bowler
Met Office (U.K.) Joint Centre for Hydro-Meteorological Research
Tel: +44 14 9169 2531
Email: neill.bowler@metoffice.com

NEW WORKING DOCUMENT

PREPARATION OF A CLIMATE DATA SET FOR THE MURRUMBIDGEE RIVER CATCHMENT FOR LAND SURFACE MODELLING EXPERIMENTS

by
Lionel Siriwardena
Francis Chiew
Harald Richter
Andrew Western

Working Document 03/1

This report describes the preparation of a climate data set for ten locations in the Murrumbidgee River Basin: Balranald, Hay, Griffith, Yanco, West Wyalong, Cootamundra, Kyeamba, Adelong, Canberra and Cooma.

The data will be used as forcing data for land surface modelling experiments. The locations coincide with the sites in the CRC's Murrumbidgee River Basin soil moisture monitoring program.

Printed and bound copies of this working document are available from the Centre Office for $22.00 (includes GST, postage and handling) or an Adobe .pdf file can be downloaded at www.catchment.crc.org.au/ publications

URBAN STORMWATER SOFTWARE

MODEL FOR URBAN STORMWATER IMPROVEMENT CONCEPTUALISATION (MUSIC)

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

MUSIC is available from the Centre Office for $88.00

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

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

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

PROGRAM 6

RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Debbie Woods

Limitations to releasing water for the environment

The River Restoration Program was established to provide resource managers with tools to plan environmental flows, design effective river restoration schemes, and assess the condition of riverine habitats. Adoption and application of these tools is a priority for the CRC. Environmental flow regimes aim to mimic natural flow patterns, of which floods are a component. Environmental floods are controlled releases of water from dams or weirs to recreate seasonal flooding patterns to maintain ecological, geomorphological and hydrological processes in a river system. Environmental flood proposals are based on the assumption that lowland floodplain rivers need floods to maintain healthy ecosystems.

There has been substantial research on the techniques available for use in environmental assessments in recent times, however little emphasis has been placed on the barriers to implementing environmental flow strategies. Environmental floods are an integral component of flow regimes, but there are very few examples worldwide of large releases of water for the environment. Environmental floods have significant potential to mitigate many impacts of dams. If they hold such potential, what is preventing their use? Recognition of the barriers to environmental flood releases will place resource managers in a stronger position to address these barriers to ensure improved conditions for the environment. This article briefly presents some issues currently limiting the release of environmental floods, and discusses the importance of the physical capacity of water infrastructure to deliver environmental floods.

Limitations to environmental floods

There are numerous barriers that exist when planning an environmental flood release. Without adequate knowledge and understanding of these, the likelihood of an environmental flood release occurring or achieving specified aims is compromised. Six groups of limitations have been identified from literature and personal communication with resource managers. Groups of limitations include: economic, scientific prediction, legal, political, infrastructure, and social structures (see Figure 6.1). There is considerable overlap between these groups, which is expected given the interdisciplinary nature of environmental management. However, the broad groups have been defined for the purpose of clarity in discussing the limitations to floods. Examples of the types of issues that constrain environmental floods are briefly outlined for the six groups, but are by no means exhaustive.

Economic Limitations

The Australian economy has historically been based upon the transformation of natural materials into goods and services. Under this economic framework, river restoration, using goods and services to return natural materials, has little apparent benefit. Services provided

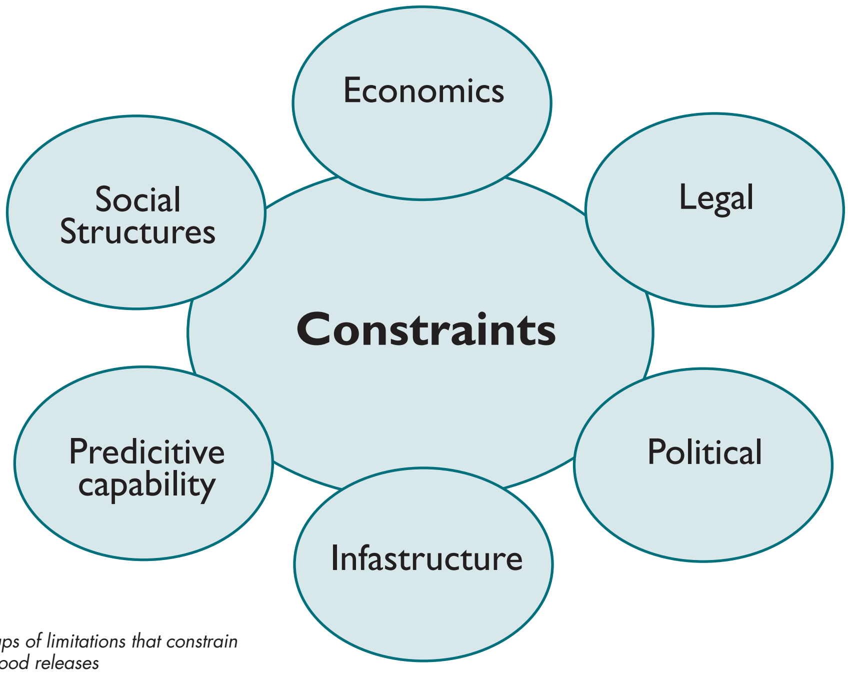

Figure 6.1 Groups of limitations that constrain environmental flood releases

by the environment are not well valued in traditional cost benefit analyses, leading to a heavy weighting of the costs of environmental floods compared with inadequately costed benefits. Costs of environmental floods include decreased productivity from loss in irrigation water, loss of income from hydro-electric power generation, delivery costs of large volumes of water, potential need to pay flooded landholders compensation, along with research and monitoring costs. Benefits of flood releases include increased bird and fish breeding and sediment and nutrient cycling. The economic value of these benefits is difficult to assess. The lack of available funds to pay for environmental floods may prohibit the release of water in many cases.

Scientific Prediction

One of the major limitations to environmental flood releases is the limited capacity of scientists to predict the complex geomorphic and ecological outcomes of an environmental flood. Natural systems do not display a system and order that is easily understood. Lack of data and the low priority to fund basic data collection programs impedes improved understanding of natural systems. Difficulties also exist in creating, calibrating and adopting models to reflect natural systems. Physical systems are spatially large and temporally variable. It is logistically difficult to monitor and measure large areas at different time scales to gain a greater understand of how natural systems respond to floods or lack of floods. Imprecise and qualitative predictions about environmental floods are generally not viewed favourably by legal and political structures.

Legal Limitations

Laws are founded upon the prohibition of certain actions. This framework is not well suited to governing complex environmental issues that are more appropriately managed through adaptive rather than prescriptive interventions. The role of administration in enforcing legal obligations is also limited as it is prone to many different interpretations and potential for inconsistencies in approaches. River systems with heavily or over-allocated water licences have the potential to cause a delay in environmental releases while new licence negotiations occur as part of COAG water reforms. The existence of legislated environmental flows also presents a significant limitation to environmental floods. This limitation is particularly poignant where minimum passing flows are legislated with no consideration for flood flows, and no consideration for legislative review. Variations between State, Federal and International legal systems also present difficulties for the release of environmental floods when compliance to one legal system leads to non-compliance in another area.

Political

Political limitations to environmental flood releases exist when qualitative predictions of environmental flood outcomes are presented to political bodies that desire visible outcomes in relatively short time spans. This limits environmental floods when they are competing against many other political agendas. The paradox of flood protection versus flooding for the environment is also highly politicised, with decisions historically erring on the side of more politically popular flood protection. Australia has a poor track record of setting and adopting environmental issues in public policy (Crowley, 1999, 46; Doyle and McEachern, 1998, 35), a fact that does not encourage the implementation of flooding for the environment. Policy changes are infrequent and span long time-frames, which works in opposition to the short time-frames that span election cycles.

Infrastructure

Dams in Australia are often designed with very large storage capacities to ensure drought supply. This leads to many small and medium floods being stored in dams, rather than spilling. Environmental floods may be desirable but outlet structures on dams may be too small to pass large flows. Exceeding channel capacity (which is often required for flooding) is undesirable for water supply authorities as it compromises flood protection of adjacent landowners.

Social Structures

Social structures are complex and transcend many different levels, from individual to national organisational bodies. Environmental floods are limited when there is little or no motivation for a flood release. This may occur because a range of other competing social issues takes priority, such as health care, welfare, education etc. Motivation for environmental floods may also be low because of the difficulty within the scientific profession to predict and provide assured positive outcomes of a flood release. If certain outcomes are not provided, motivation and enthusiasm for the management intervention is likely to be low. Conflict within stakehholder groups during consultative periods may also delay or limit flood releases, whist power relations within administrative bodies or stakeholder groups may sway environmental planning outcomes in various directions.

Importance of investigating infrastructure constraint

All of the six groups of limitations to environmental floods should be addressed if an environmental flood release is to occur. The physical capacity of dam infrastructure is

CRC SHORT COURSE

Design of Rock Chutes for Stream Bed Stabilisation

15 August 2003
City venue, Melbourne

This CRC short course targets professional engineers and managers involved in stream rehabilitation and restoration.

Presented by:
Assoc. Prof. Bob Keller (CRC)
Dr Tony Ladson (CRC)
Frank Winston (CRC)
Dr. John Tilleard (Earth Tech)
Ross Hardy (Earth Tech)

Registration for the Workshop costs $330 and places are limited to 40 participants.

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viewed as a critically important limitation to address at the outset of planning an environmental flood release. This is because environmental floods are managed releases of water, and if the release cannot occur due to limitations in dam outlets or other physical limitations, then there is little value in addressing the other limitations.

Assessing the limitations to environmental flood releases is part of a broader research project on environmental floods. Other aspects that are considered include the impact of dams on the flood hydrology of selected Victorian rivers and an analysis of the physical capacity of Victorian dams to release environmental floods. For further information on this research project, contact Debbie Woods at The University of Melbourne.

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Debbie Woods
Tel: (03) 8344 3947
Email: d.woods1@pgrad.unimelb.edu.au

Report by Myriam Ghali

The need to define stream rehabilitation terms

Everybody agrees on what "stream restoration" and "stream rehabilitation" mean, don't they? These terms define the 'goals' and objectives of the huge amount of work people are doing on Australian streams, so it is important to check that we all have a shared understanding. This is particularly important for my research into Priority Setting in Stream Rehabilitation in Victoria. I have conducted 30 formal and informal interviews, with 17 individuals representing all nine Catchment Management Authorities (CMAs) in Victoria. The aim of these interviews was to identify what drives the priorities set by relevant waterway professionals. I asked the interviewees how they define 'restoration and rehabilitation, and if their answers were similar to the more 'academic' definitions in the literature.

Table 6.1 lists how the terms restoration and rehabilitation are technically used in ecosystem restoration and consequently in stream management.

The two terms can be broadly explained as follows:

a) restoration is returning a stream to its original (pre-European) condition and

b) rehabilitation is improving some aspects of a stream to make it closer to its original condition.

But what does this mean in terms of project design? Well, it all comes down to the objectives and feasibility of a project.

Table 6.1: Technical application of the terms rehabilitation/restoration in stream management.

Restoration in stream ecosystems (Breen and Walsh, in Rutherfurd *et al.* 1999)	**Restoration in ecosystems** (Cairns, Jr., J. 1991)	**Restoration in ecological/aquatic systems** (U.S. EPA 1995)
Restoration involves returning the stream to the original, pre-European condition.	Restoration means recreating the structural and functional attributes of a damaged ecosystem.	Restoration of chemical, physical, and/or biological components of a degraded system to a pre-disturbance condition and is also an important tool for preventing environmental degradation.
Rehabilitation in stream ecosystems (Breen and Walsh, in Rutherfurd *et al.* 1999)	**Rehabilitation in ecosystems** (Cairns, Jr., J. 1991)	**Rehabilitation in river systems** (Brookes and Shields, 1996)
Rehabilitation involves fixing the most important aspects of the stream, but generally making the degraded stream closer to the original condition.	Rehabilitation means replacing selected original attributes of particular value to humans.	Rehabilitation is a partial return to a pre-disturbance structure or function.

The objectives of restoration projects as described by the National Research Council (1992) in Rutherfurd *et al.* (1999) were to:

- restore the natural range of water quality;
- restore the natural sediment and flow regime;
- restore a natural channel geometry and stability;
- restore the natural riparian plant community;
- restore native aquatic plants and animals.

These restoration objectives cover a wide range of physical and ecological features which distinguish original streams. Yet, very rarely can streams be brought back to their original state, bearing in mind the relatively unknown condition of the original streams.

Over the last 200 years in Australia too many changes have occurred to channel forms, stream connectivity, and stream networks, and consequently to their ecological features. Therefore, it is hardly feasible to aim for the above mentioned restoration objectives, considering the strong human impacts which changed many streams irreversibly.

Rehabilitation, however, is focusing on the improvement of the most important aspects of a degraded stream, enhancing and protecting valuable physical and biological features. Thus, rehabilitation returns as much "originality" back to a degraded system as possible (See Figure 6.2).

Given the range of possible interpretations, I asked the waterway professionals "How do you define stream restoration and stream rehabilitation"? The majority of responses obtained were similar.

Seven out of the ten interviewees defined the two terms in a similar manner to that given in the literature. It was noted, that at least in one case, the answer differentiated between a person's professional ability to define these terms accurately, and the actual operational use of these terms in his/her organisation. These two important issues are amplified by the answers given by the remaining three interviewees. The three interviewees defined the terms restoration and rehabilitation as interchangeable or similar, or confuse one for the other. Consequently, the comments they made about their operational work were therefore influenced by these incorrect definitions.

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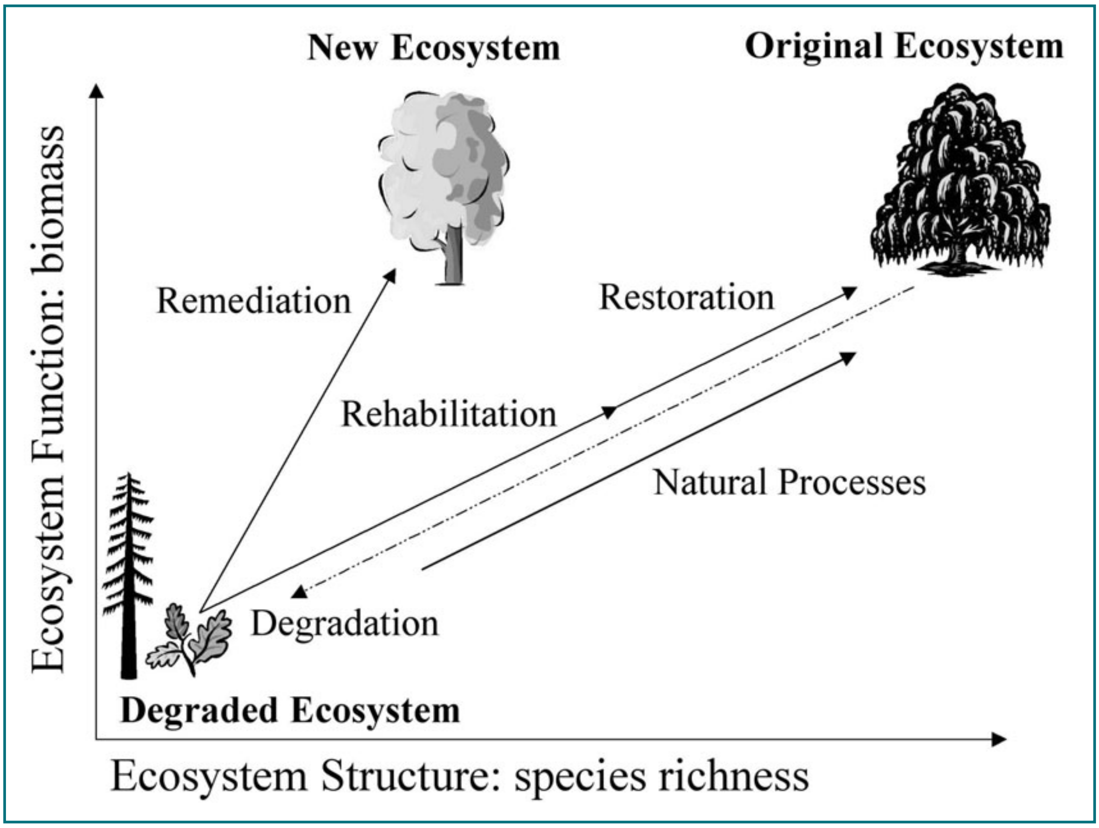

Figure 6.2: Differences between Restoration, Rehabilitation and Remediation, after Breen and Walsh, from Bradshaw (1996), in Rutherfurd et al. (1999).

Imprecise definition of these terms can easily lead to confusion and unclear objectives in stream projects. If waterway professionals think they are rehabilitating, and the community thinks they are restoring, it is unlikely that the project will be easy to evaluate! So it is encouraging to see that there is a shared understanding of these, often vague, terms amongst the people who have to implement these ideas in our waterways. Of course, there is still room for some improvement, and we will report more on the details of planning and priority decision-making for stream rehabilitation projects.

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

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect – July 2003

At a glance

This month's article is an update on the Catchment Modelling Toolkit, a forthcoming Rock Chute Course and new publications.

Update on the Catchment Modelling Toolkit web site
I am very pleased to announce that the Catchment Modelling Toolkit web site has been completely revised. This achievement represents an important step towards delivering the Catchment Modelling Toolkit. The site at www.toolkit.net.au is in its very early stages but represents a significant advance in our capability to support our Toolkit products as they are developed.

Currently information and support for MUSIC (Model for Urban Stormwater Improvement Conceptualisation) only is available through the site, but over the next few months more products will be added. If you would like to learn more about the Toolkit and the Toolkit web site visit www.toolkit.net.au and please use the feedback facility – we would like to know what you think.

On a personal note I would like to thank Susan Daly, Harold Hotham, Rob Vertessy, Geoff Podger, Rob Argent, Joel Rahman, Nick Murray, Tim Fletcher and Daniel Figucio for the team effort in developing and deploying this site to date.

Rock chute training course- Melbourne, 15 August 2003
The River Restoration Program will present a course on the design of rock chutes for stream bed stabilisation in Melbourne's City Centre on Friday 15 August 2003.

The one-day course targeting professional engineers and managers involved in stream rehabilitation and restoration, has been designed to equip attendees with:

- An understanding of some of the causes and effects of instability of stream beds
- A thorough introduction to the computer program CHUTE for the hydraulic design of rock chutes for the stabilisation of stream beds; and
- A review of associated issues such as rock gradation, crest design, filters and hydraulic cutoffs, fish passage considerations, and treatment of abutments.

Participants will develop a sound understanding of design guidelines for rock chutes through case studies and theoretical considerations.

The course is offered as an intensive one-day program and includes a comprehensive set of course notes and a CD-ROM containing the CHUTE software and the manual 'Design Guidelines for Rock Chutes' (Adobe .pdf format).

Speakers include Assoc. Prof. Bob Keller, Dr Tony Ladson and Frank Winston (CRC for Catchment Hydrology and Monash University); Dr. John Tilleard and Ross Hardy (Earth Tech Pty Ltd).

For further information see the sidebar on this page or visit the Catchment Modelling Toolkit web site at www.toolkit.net.au/news

Life Cycle Costing for Stormwater Managers - Introductory Paper
Staff from the Urban Stormwater Quality Program have recently been gathering costing data for stormwater treatment measures (e.g. wetlands, vegetated swales, gross pollutant traps) from stormwater management agencies across Australia. This data will be used to build a 'life cycle costing module' into the CRC's MUSIC model, to allow stormwater managers to easily calculate approximate life cycle costs for a given 'stormwater treatment train'.

A finding during the data gathering exercise has been that many small to medium sized stormwater management agencies are seeking guidance on basic life cycle costing, and the data that should be collected to allow life cycle costing of stormwater treatment measures to occur.

To help service this need and to facilitate improved data gathering in the future, a paper has been written to explain the basics of life cycle costing in the context of stormwater quality management. The paper includes a 'Data Recording Sheet' to highlight those pieces of information that the CRC recommends be collected throughout the life cycle of stormwater treatment measures.

The paper can be downloaded from the CRC's web site at www.catchment.crc.org.au/news or for further information, please contact:

André Taylor
Research Fellow
Cooperative Research Centre for Catchment Hydrology
Tel/Fax: 02 6581 2649
e-mail: andretaylor@iprimus.com.au

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For more information please visit www.catchment.crc.org.au/news or contact Cameron Neil tel (07) 3875 7457 fax (07 3875 7459 RRR03@environmentaladvocacy.org

New Publications

The Murray-Darling Basin Commission, CSIRO Land and Water and the CRC for Catchment Hydrology have produced a series of five new technical reports. The reports are not currently available as printed documents but can be downloaded as Adobe .pdf files from the CRC web site. Visit 'www.catchment.crc.org.au/publications' and search under the Land-use Impacts on Rivers Program. The five reports are:

- A Critical Review of Paired Catchment Studies With Reference to Seasonal Flows and Climatic Variability by Alice Best, Lu Zhang, Tom McMahon, Andrew Western and Rob Vertessy. CRC for Catchment Hydrology Technical Report 03/4
- Impact of Increased Recharge on Groundwater Discharge: Development and Application of a Simplified Function Using Catchment Parameters by Mat Gilfedder, Chris Smitt, Warrick Dawes, Cuan Petheram, Mirko Stauffacher and Glen Walker. CRC for Catchment Hydrology Technical Report 03/6
- Modelling the Effectiveness of Recharge Reduction for Salinity Management: Sensitivity to Catchment Characteristics by Chris Smitt, Mat Gilfedder, Warrick Dawes, Cuan Petheram and Glen Walker. CRC for Catchment Hydrology Technical Report 03/7
- Testing in-class Variability of Groundwater Systems: Local Upland Systems by Cuan Petheram, Chris Smitt, Glen Walker and Mat Gilfedder. CRC for Catchment Hydrology Technical Report 03/8
- Assessment of salinity management options for Kyeamba Creek, New South Wales: Data Analysis and Groundwater Modelling by Richard Cresswell, Warrick Dawes, Greg Summerell, Geoff Beale, Narendra Tuteja and Glen Walker. CRC for Catchment Hydrology Technical Report 03/9

For further information about this report series email: info@mdbc.gov.au or mat.gilfedder@csiro.au

David Perry
Communication and Adoption Program
Tel: 03 9905 9600
Fax: 03 9905 5033
email: david.perry@eng.monash.edu.au

POSTGRADUATES AND THEIR PROJECTS

Courtney Henderson

Background

My journey towards joining the CRC for Catchment Hydrology began in high school in Brisbane. It was there that I discovered that I felt some affinity for science, and in particular, biology. So following these cues I found myself studying environmental science at The University of Queensland. Here my interests and skills began to focus on botany, ecology and water quality. During university field excursions I began to learn about some of the impacts of urban development on the fragile coastal ecosystems - a subject that interested me more and more as I spent a substantial part of my leisure time in these environments. This interest culminated in an honours thesis which investigated the impacts of urban runoff on a coastal lowland heathland. My study showed that the hydrological impacts of urban development (declining water quality and increased flow and scour) damaged the fragile and nutrient poor heathlands, perhaps irreversibly. Exotic weeds took over any disturbed areas and thrived on nutrients brought in by with stormwater. The delicate heathlands were slowly being overrun by weeds. Although I was completely unaware of the existence of the CRC's urban stormwater quality program, I had discovered stormwater.

Then I took a break from science to focus on some other things I really wanted to do. Six months in French Polynesia saw me learning French and the finer points of how waves form over coral reefs. I visited many relatives and friends in the USA and Europe, and spent a few months of bliss in Indonesia, before returning to study for a semester at a university in Montpellier, France to refine my fairly rudimentary understanding of their language.

Upon my return to Australia I spent 18 months working for the Queensland Department of Natural Resources and Mines on their "State of the Rivers" Program. At the completion of this project I joined the team at Marine Botany (University of Queensland) as a research assistant, studying the ecosystem health of Moreton Bay and the Brisbane River.

After three years of studying the decline of water quality and its effects, I was wondering if there was something more proactive that I could do, and this led me to the CRC. I became interested in stormwater treatment devices because of the way that they harness biology and ecology to improve water quality. I was looking at research institutions around the world when I found that I could do this kind of work at Griffith University in Brisbane! And there were scholarships available! So I joined the CRC.

The project

The project forms part of the Urban Stormwater Quality Program, Project 4b - Stormwater Best Management Practices. The research focuses on the effectiveness of biofiltration systems for stormwater quality improvement. A biofiltration system consists of a bed of porous media such as gravel or sand that is underlain by perforated pipes. Vegetation can be planted in the media. Pollutants are removed as the stormwater filters through the root zone of the vegetation, and through the media. The filtered water is collected at the bottom of the media by the perforated pipe that discharges this "treated" water to the stormwater drainage network or waterways. Biofiltration systems show great potential as an alternative to constructed wetlands for water pollution treatment. Because they can be vegetated, they can be easily incorporated into garden designs and landscaping features of housing lots, car parks, green spaces and streetscapes.

My research will focus on the chemical and biological processes responsible for transforming and removing dissolved nutrients from stormwater in biofiltration systems. To this end I have constructed 30 small-scale biofiltration devices in 240 litre plastic containers (wheelie bins). These bins have been specially constructed to facilitate the collection of filtrate from different depths within the substrate, and to allow probes to be inserted into the filter media. Different soil types and vegetation will be investigated to measure their contribution to the filtration process. The vegetation will be given several months to establish before full testing begins. Several large-scale operational biofiltration systems are also being monitored for comparison with the experimental systems. My supervisors at Griffith University are Assoc. Prof. Margaret Greenway and Dr Ian Phillips.

The results of this research will inform and aid the design of stormwater biofiltration systems as well as informing the biofiltration components of the CRC's Model for Urban Stormwater Improvement Conceptualisation (MUSIC).

Courtney Henderson
Tel: (07) 3875 5534
Email: courtney.henderson@student.gu.edu.au

NEW TECHNICAL REPORT

ESTIMATING WATER STORAGE CAPACITIES IN SOIL AT CATCHMENT SCALES

by

Neil McKenzie
John Gallant
Linda Gregory

Technical Report 03/3

The capacity of models to provide reliable predictions of catchment behaviour is increasingly being constrained by the quality of input data. Soil and landscape attributes can affect water and pollutant balances but appropriate data, even for synoptic modelling, have not been readily available across large parts of Australia.

This report addresses the estimation of water storage capacities in soils at catchment scales. It demonstrates how careful integration of digital terrain and conventional land resource data can benefit catchment hydrology.

Printed and bound copies of this report are available from the Centre Office for $27.50 (includes GST, postage and handling).

Centre Office
tel: 03 9905 2704
fax: 03 9905 5033
email: crcch@eng.monash.edu.au

CRC PROFILE

Our CRC Profile for July is:

Christy Fellows

If you had asked me ten years ago to predict where I would be and what I would be doing today, I certainly could not have done better than one out of two, because I would have picked the wrong continent. Ten years ago, I was on summer break during my undergraduate studies at the University of Maryland in the eastern U.S, and I would have told you that there was almost no chance I'd end up anywhere except North America. Nevertheless, I'm here in Brisbane after starting in August 2000 what I thought would be a two year postdoctoral position at Griffith University. The reasons I'm still here, in no particular order of importance, are that I've come to realise that AFL is the best sport ever (Go the Lions!), I married a native Brisbanite in 2002, and I've become involved in so much exciting research in Queensland and elsewhere in Australia.

Although I never would have recognised it at the time, my path towards the CRC for Catchment Hydrology started with the research for my Senior Honours Thesis entitled "Characterisation of groundwater flow in Battle Creek Cypress Swamp, Calvert County, Maryland." Through the installation of more than 30 piezometers and wells, I began honing the soil auger skills I would revisit during CRC for Catchment Hydrology Project 2.5: 'Nitrogen and carbon dynamics in riparian buffer zones'. I graduated in 1995 with a bachelor of science in biology and a bachelor of science in geology, and went straight into the PhD program at the University of New Mexico, which I had chosen because of the close collaboration between the biology and geology departments there.

My PhD research addressed the questions: 1) What is the relationship between energy flow and nitrogen cycling in stream ecosystems? and 2) What is the influence of hydrology on stream ecosystem processes? I investigated stream ecosystem metabolism (energy flow) and nitrate retention and the influence of hydrology on these processes in four headwater streams with differing amounts of surface-subsurface water exchange. This research provided evidence that hydrologic interactions between surface waters and ground waters are crucial to nutrient and carbon cycling in stream ecosystems, and these interactions need to be considered both when studying the ecology of streams and in making management decisions.

In addition to keeping me in Brisbane over the past couple of years, Australian sport was indirectly responsible for my getting a postdoc with Stuart Bunn at Griffith University in the first place. When I was nearing the end of my PhD in late 1999, a faculty member on study leave from Charles Sturt University used to come into my office daily to check the cricket scores. He happened to be working on a manuscript with Stuart Bunn at the time, who happened to be looking for a postdoc to start mid-year on a project investigating nitrogen dynamics in riparian zones.

My involvement in the CRC started with that project on riparian zones, Project 2.5, which just finished recently. I'm now part of Project 2.22, Modelling and managing nitrogen in riparian zones to improve water quality, which started in January this year. Both these projects are joint projects with the CRC for Coastal Zone, Estuary and Waterway Management, and involve the Queensland Department of Natural Resources and Mines as well as Griffith University. In addition to these two riparian zone projects, my research since coming to Griffith has focused on three other topics: in-stream nitrogen and carbon cycling, controls on primary production in dryland rivers, and measures of ecosystem processes as indicators of stream ecosystem health.

I won't even venture a guess about where I'll be ten years from now, but rivers and their riparian zones will likely still be captivating my attention.

Christy Fellows
Tel: (07) 3875 3840
Email: c.fellows@mailbox.gu.edu.au

WHERE ARE THEY NOW?

Report by Andrew Barton

The first quarter of this year was incredibly busy. I managed to write the majority of a Masters thesis, I married my long time partner Lisa in late February, and also pulled up roots and made the move to Hobart, Tasmania. Why Hobart? Because it's a beautiful little city, and what better place to continue your postgraduate education! So here I am sitting in my office at the School of Engineering, University of Tasmania, having just started my PhD.

I submitted my Masters thesis in May 2003. The thesis was entitled "A numerical model for the hydraulics of the vertical slot fishway." The purpose of the research was to investigate the ability of a numerical model to predict hydraulic variables within a Vertical slot fishway (VSF). A predictive ability could be used to better design VSF's for target fish species based on their swimming abilities. The numerical model utilised computational fluid dynamics methodology in a commercially available package called FLUENT. The end product was a sophisticated numerical model, fully verified, able to predict 3D velocity distributions and water surface elevations. The predictions were shown to be most reliable for relatively mild slopes of around 5%. Greater fishway slopes proved difficult to accurately simulate.

I'd like to thank Bob Keller for his supervision of the Masters. I'm also grateful to Lindsay White who provided valuable experimental data, which were used to verify the numerical model. Numerous other individuals (Peter Kolotelo, Chris Katopodis, and John Harris) also contributed to the success of my Masters program. Thanks to them also.

Here at UTas, the research program I'm involved with is part of an ARC linkage project. Hydro Tasmania, the industry partner, is very interested in improving the water conveying efficiency of their hydraulic conduits. Basically they want to restore the carrying capacity of their open-channel and pipe networks to their original design capacity, or as near to that as possible. This will enable to them optimise their power generating capacity, of special significance on completion of the Bass link project and the entry into the National Electricity Market. Dr Jane Sargison (a Rhodes scholar) is managing the project, and is also supervising my PhD program.

More specifically, I'll be researching the reduction of conduit carrying capacity due to biofouling. Biofouling is the generic term used to describe the undesirable effects due to attachment of microorganisms on the surfaces of pipes and canals. The biofouling causes a general reduction in cross section of the conduit, but more importantly, deposits of algae and bacteria on the conduit walls cause roughness effects and consequently friction (energy) losses. The core of my PhD will include detailed measurements of the hydrodynamic flow field, in order to develop relationships between the physical biofilm roughness and the friction effect it has on the flow. Hydraulics facilities at UTas and the Australian Maritime College (which houses a world class cavitation tunnel) will be used.

Experimental programs will be complimented with Hydro Tasmania field sites located in central Tasmania (Tarraleah) and the northwest (Wilmot – on the foothills of Cradle Mountain). Test plates coated with various paints/finishes are currently immersed in concrete lined canals at Tarraleah and will be tested for their ability to retard biofilm growth over time. Also, pressure testing of a penstock at Wilmot hydro powerstation has taken place and will be used to reveal headloss data pre and post cleaning of biofoul material.

So all is good down here in Tassie. We had our first major snow fall on Mount Wellington (approx. 1300m) not long ago. Makes for a nice backdrop out the kitchen window in the morning!

Andrew Barton
Tel: 03 6226 2142
Mobile: 0428 132 893
Email: afbarton@postoffice.utas.edu.au

COOPERATIVE RESEARCH CENTRE FOR

CATCHMENT HYDROLOGY

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If undelivered return to:

Department of Civil Engineering
Building 60
Monash University
Vic 3800

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CENTRE OFFICE:
CRC for Catchment Hydrology
Department of Civil Engineering
Building 60 Monash University,
Vic 3800
Telephone: +61 3 9905 2704
Facsimile: +61 3 9905 5033

crcch@eng.monash.edu.au

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
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