NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 130 AUGUST 2004

A NOTE FROM THE DIRECTOR

Rodger Grayson

Inside...

MODEL CHOICE, EXPECTATIONS AN RESPONSIBILITY

Our CRC is about delivering capability, and a key component of this objective is the provision of modelling software and support materials, made available through the Catchment Modelling Toolkit website. When this idea was first raised some years ago, there was much debate about whether there was really a big enough market out there to justify such an investment. But the proof of the pudding has been in the eating. Over the last couple of months we have released several new and updated products to over 1800 registered toolkit users with now over 3500 downloads since November 2003. Of course the number of people downloading software does not equate to delivery, but it is a strong indication of the interest in our work.

Recently I have had the opportunity to tour around the Parties in each State and the need for high quality tools to assist with land and water management has been reinforced time and again. With significant funding available through mechanisms such as the NAP (National Action Plan on water quality and salinity) and NHT2 (Natural Heritage Trust), agencies and regional groups are in urgent need of tools to assist with the assessment of alternative management actions, target setting, and to help with optimising investment.

The success of the CRC's Development Projects in applying our tools to real problems has also generated considerable interest, particularly in SedNet and EMSS. There are now many groups outside the CRC looking to our models to help them with their natural resource challenges. This is a fantastic result, but brings with it some issues that require careful attention.

As I discussed in the special issue of *Catchword* on Development Projects in April this year, these projects are designed to build capacity within organisations to use our models and develop strong skills in model application and interpretation by researchers and industry parties working closely together. This close relationship facilitates a clear communication and understanding of model capability and appropriate use. As the word is spread further and further, this understanding can become somewhat hazy. A serious issue for our CRC is the possible misunderstanding about what our models can and cannot do. Some of the external expectations I have heard over recent months are quite unrealistic and have the potential to undermine our goal of having modelling being integral to good land and water management. Appropriate use and interpretation of models is the responsibility of all involved, from researchers and software developers to users and advocates of modelling.

As researchers and developers of software for land and water managers, we are committed to providing high quality products based on sound science and backing this up with high quality training in model use. Part of this approach involves being very clear about model capability and applicability to particular problems. We are meeting this need through our training activities such as the Catchment Modelling School and regular workshops around Australia. But there appears to be a more general need in the industry for communication of "good modelling practice" and assistance in choosing the right model for the job.

While we can never hope to prevent misunderstanding or over-expectations about our models, I believe we can do more to minimise these problems. These misunderstandings and over-expectations have the potential to reduce confidence in modelling, not because of a particular deficiency of a model, but due to a poor appreciation of what it was designed to do.

Face to face training will continue to be our key strategy for improving technical understanding and learning about our products, but we are also preparing a series of new communication activities to reach a broader audience. These include a range of printed information to support better model choice, a special issue of *Catchword* (in November 2004) and a seminar series. These initiatives will address the fundamental issues of choosing the right model for the job, summaries of the capability of our models, and assistance with choosing between several models that on face value do the same thing. This will become increasingly important as the number of products in the Catchment Modelling Toolkit increases. For example, by June 2005 we expect to have four models that deal with salinity issues, and a similar number that deal with sediment and nutrient issues. Each model will have particular strengths and weaknesses and will be applicable to quite different types of management question. Plurality is a hallmark of our Toolkit philosophy, but just providing a lot of models is not enough - we need to help users choose the best 'horse for the course'.

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CRC PUBLICATIONS LIST

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

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This challenge of "expectation management" is a wonderful one to have since it arises from the great interest in what we are doing. Dealing with it will be a terrific opportunity for the CRC to raise the general level of understanding about the role of models in land and water management, and to learn even more about the needs of the industry. Of course this challenge is not ours alone. While we will continue to do our best, ultimately the responsibility for appropriate use and interpretation of modelling rests with all model users, developers, advocates and purchasers of modelling outcomes.

Finally, I would like to thank all those involved in releasing new and updated products over the last couple of months. The behind-the-scenes work that goes into a release is enormous and the product managers, software teams and project teams have been working tirelessly to produce professional products of which we can all be proud.

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Report by Robert Argent

Development of Whole-of-Catchment Modelling System

Introduction to E2 - whole-of-catchment modelling system
In the May *Catchword* I introduced the concepts underlying E2, the whole-of-catchment modelling system of the CRC for Catchment Hydrology. This system is being developed over a series of stages, with the first stage released internally this month.

E2 has been designed to provide a flexible capability to support construction of models for analysis of the impacts of land use and water management decisions at the whole-of-catchment scale - very much aligned with the mission of the CRC for Catchment Hydrology. This concept of a 'flexible capability' combined with a 'land and water' modelling system is what sets E2 ahead of other major models and modelling systems used in hydrology and land management today.

Modelling issues and features
The majority of models used today have a fixed set of algorithms into which a variety of parameter and variable values can be loaded, giving some flexibility to tailor a fixed model structure to a particular problem. Difficulties arise, however, when the fixed algorithms are not appropriate to the scale, complexity or data availability of the problem at hand.

Some dynamic time-stepping modelling systems in use today provide a virtual empty canvas upon which modelling artists can create their interpretations of the management landscape. However, these are often too generic with little or no support for common hydrological modelling problems (eg alternative rainfall-runoff models) and have limited ability for the spatial manipulation requirements common in catchment management modelling.

At the other end of the scale, geographic information systems often provide a bewildering array of spatial data manipulation tools, and some quite useful modelling capability through the use of macro scripts. These systems, however, often have a rigid approach to the management of spatial data and lack implicit handling of temporal data, requiring temporal modelling structures to be built in 'from the ground up'. Thus they do not provide the capabilities needed for the breadth of modelling envisaged within the mission of the CRC for Catchment Hydrology.

E2 and modelling challenges
Readers of *Catchword* will know that the above problems are neither new nor unique, and that they have been part of the Program 1 mantra for four years. They have certainly been recognised within parts of the hydrological model development community for much longer. So, what has changed, and why does this make E2 so special? The answer lies in the depth of software engineering experience and the breadth of conceptual development upon which E2 is being built. CRC for Catchment Hydrology researchers and colleagues across the globe have been involved in shaping the new generation of catchment modelling tools for over ten years, including development of the Open Modelling Engine, Integrated Catchment Management System (ICMS), Catchment Simulation Shell, the Tarsier modelling system, the Environmental Management Support System for South East Queensland (EMSS), the TIME modelling system, and the Catchment Modelling Toolkit. Application of these systems to real catchment management problems gives us both invaluable experience in building useful models and the confidence that we can do better.

Features of current E2
Construction of E2 provides an interesting challenge for the CRC model designers and software engineers - to provide a system that is rigid enough in structure so that much of our existing library of Catchment Modelling Toolkit tools can be made available to users, and flexible enough that we can support a range of modelling approaches of different complexity and at different spatial and temporal scales. The current internal release of E2 has, on the surface, a relatively simple capability. The software structure underlying it has been constructed with the complete set of E2 capabilities in mind, to ensure there is little re-construction required as capabilities are added and tested over coming months. E2 allows users to assess contaminant loads being generated from a mix of land uses over a catchment, to route generated loads to receiving waters, and to assess the impacts on loads of a range of management options, such as changes in land use or land management.

Using E2
Upon starting E2, users create a new project, which is then populated with models, data and parameters. The basic data set for this version of E2 is a sub-catchment map, loaded through either a file open menu, and via the regular drag-and-drop method common to many Catchment Modelling Toolkit applications. With sub-

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

TIME TRAINING WORKSHOP

A TIME training course is scheduled for 16-17 September 2004 in Canberra.

This two-day course covers the development of environmental models and modelling applications within The Invisible Modelling Environment (TIME). TIME is a modelling and programming system for rapidly developing, applying and deploying environmental models. The programming languages used are C#, VB.NET or Lahey Fortran 95.NET.

The TIME workshop led by Nick Murray and Joel Rahman costs $880 (inc. GST) or $660 concession for CRC Party and Affiliate staff.

For further information and to register on-line please visit www.clw.csiro.au/conferences/time/index.html

catchments loaded, a node-link network is defined by a 'point, click and drag' method using the mouse. This sub-catchment map and network form the basic structure of the model. Within the model, functions units (FUs "foos") are defined, and each FU is assigned a rainfall runoff model, contaminant generation models and contaminant filters, thereby creating the capability to generate, transport, and remediate catchment contaminant loads. Figure 1.1 shows an example catchment.

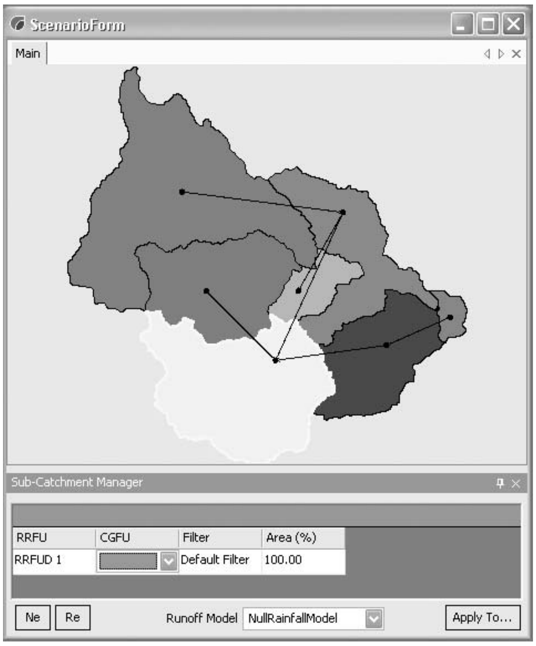

Figure 1.1 Catchment example from E2.

Scenario exploration is undertaken through changes to model parameters, and changes to model structure are enacted by selecting different types of generation, transport and filter models. Thus, the first release of E2 provides a simple but effective tool for assessment of contaminant loads from different catchments and of the likely changes arising from a range of simple catchment treatments.

Next steps

Development of the E2 software, documentation and help system will be ongoing for at least the next nine months, with periodic releases. The first version has been released to an internal audience for testing of software, algorithms, reliability and effectiveness of communication, and will be extended to external users later in the year.

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PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER WALLBRINK

Report by Scott Wilkinson, Joel Rahman, Tim Ellis, Harold Hotham

Project 2.20 (2B) update: SedNet, Sediment Delivery and Software testing

Project changes and aim

The last nine months has been an interesting period for CRC Project 2.20 (2B): 'Sediment and nutrient budgets for modelling water quality in river networks'. In October 2003, the project team was re-established following the departure from the CRC for Catchment Hydrology of several key team members, including the project leader. The new team, and new project, has as its main goal to deliver SedNet as a CRC Catchment Modelling Toolkit application. SedNet has been operating on the ArcInfo platform for several years, developed by CSIRO Land and Water to construct spatially distributed sediment and nutrient budgets for the NLWRA, and for numerous regional catchments since. These budgets have proven to be very useful for identifying dominant sediment sources, and targetting erosion control to erosion hotspots in catchments.

SedNet and the Catchment Modelling Toolkit

The aim of delivering SedNet into the CRC Catchment Modelling Toolkit is to provide catchment managers with the ability to assess sediment issues in their catchments for themselves and then to simulate the outcomes of various erosion control scenarios in a dynamic way. This can assist with developing end-of-valley targets for reducing sediment loads.

Training at Catchment Modelling School

SedNet version 1.0.0 was delivered at the Catchment Modelling School in February this year. Over three weeks Scott Wilkinson, Harold Hotham and Shane Seaton trained over 40 people, drawn from the CRC Development Projects, State agencies, research organisations and consultants.

Feedback from users

The software delivered at the school was brand spanking new and the workshop provided an excellent opportunity to road test it under a variety of conditions and to identify its strengths and weaknesses. The feedback from this exercise (both positive and negative) has been extremely valuable. Over 200 people have downloaded SedNet since its release (www.toolkit.net.au/sednet). The email list has seen some activity as users explore the features of the software and go about preparing input datasets.

Improving software stability and quality

In the months following the Catchment Modelling School, we have learnt some hard lessons about how to improve software stability, and also how to conduct quality assurance testing. We'll summarise them here, since the methods we have developed are potentially useful to many toolkit products. Essentially, we had ported a large, whole-of-catchment model to a different modelling environment (TIME), on a slim software engineering budget. Porting a model can introduce subtle errors and we lacked a systematic approach to ensuring that the TIME implementation of SedNet reproduced the same results. To flush out any inconsistencies between the original and ported SedNet, we tried comparing the algorithms line-by-line, and we also tried increasing the level of detail in the software specifications. Both of these activities were time-consuming and they also do not guarantee success.

Unit test approach

The method that we have found to work best is to construct unit tests for each algorithm in the model. This method was discussed briefly in the Program 1 report by Joel Rahman in the June 2004 *Catchword*, so it is now timely to provide some more detail on what unit tests are, how to build them, and how to manage quality assurance testing of a toolkit product using them.

Unit test operations

A unit test is a set of operations and test data that objectively test the correctness of a software component.

A unit test consists of three parts:

- An initial condition. This includes base input data for a component.
- An operation to perform, such as calling a particular function or running a model.
- An expected result. What result or results from the operation are considered valid?

Unit tests are particularly appropriate when porting an existing model from another codebase, such as porting SedNet from Arcinfo to TIME. In this case, the input data and the expected results come from the original Arcinfo version of the model. The test then runs one component of the TIME version and compares the results against the results from Arcinfo.

Unit tests are configured to run automatically, including the evaluation of the results. This way many unit tests can be combined together into a test-bench that can be run repeatedly and regularly.

Application of unit tests to SedNet

In the case of SedNet, unit tests were constructed for each step of the modelling process, including the various pre-processing steps such as terrain analysis and flow calibration. This allows any errors detected to be narrowed down to a small block of code. These individual tests are then combined into larger, sequential tests, which ensure the various components of the model are 'connected' correctly.

Unit tests can also be useful when constructing new models. For example, unit tests can be constructed to ensure that mass balance is conserved for particular constituents.

The development of unit tests is an investment in the long-term stability of the software application. By re-running the tests as the models and applications evolve, we always know exactly where the TIME version of the model differs from the Arcinfo. If a bug is reported in either version, we can expand the unit tests to detect the bug. This way, we can ensure that the same bug cannot reappear in a future version.

The test results are published on an internal website that is updated regularly for the project team to see (Figure 2.1).

Looking ahead

This month, software testing should be complete and we plan to release an updated version of SedNet. A follow-up release will be made later in 2004, containing some extra features to allow greater flexibility in simulating management scenarios. These will include the ability to vary the sediment generation rate from gullies; area-specific quantities for targetting erosion hotspots; and several user-requested visualisation improvements. Next year SedNet will also incorporate improved bank erosion and channel metrics algorithms from Project 6.12 (6B): 'Predicting spatial and temporal variations in channel form'. We are also providing some guidance to E2 developers on ways of incorporating sediment generation routines.

Hillslope Sediment Delivery Ratio

One CRC Project 2.20 (2B) activity that is external to delivering SedNet in the Catchment Modelling Toolkit is some research into calculating Hillslope Sediment Delivery Ratios (HSDR). This ratio is the proportion of sediment mobilised on hillslopes by sheet-wash and rill erosion that actually makes it to the stream network. This research aims to provide a spatially explicit method for estimating HSDR and has included:

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

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

1) Incorporation of the hillslope component of the HSDR model developed by Hua Lu *et al.* (2001), who described a method for calculating sediment generation at the hillslope scale and subsequent delivery to stream. The authors considered the flow path and flow duration of suspended sediment to determine the resulting deposition en route.

2) Linking the approach in 1), applied at the hillslope scale, to a method of Ellis *et al.* (in review) who applied the net sediment deposition model of Peter Hairsine by first considering steady-state channel hydraulics. This will allow description of deposition (and re-entrainment) processes in channels at a reach scale and possibly down to the resolution of the underlying DEM.

3) Describing the effect of farm dams on sediment delivery. We are also considering the number of times flow encounters dams en route from hill top to stream and then accounting for the trapping efficiency of the dams.

Members of the iCAM group (ANU) are providing some observed load data from mid-Murrumbidgee catchments to assist with evaluation of these approaches.

Reference

Lu, H.; Moran, C. J.; Prosser, I. P.; Raupach, M. R.; Olley, J., and Petheram, C. (2001) Sheet and rill erosion and sediment delivery to streams: A basin wide estimation at hillslope to medium catchment scale. Technical Report 15/03, CSIRO Land and Water; Canberra

All in all it is a very busy time for the Project 2B team, although with persistence we are well on track to deliver the core functionality of SedNet to the Catchment Modelling Toolkit by June 2005.

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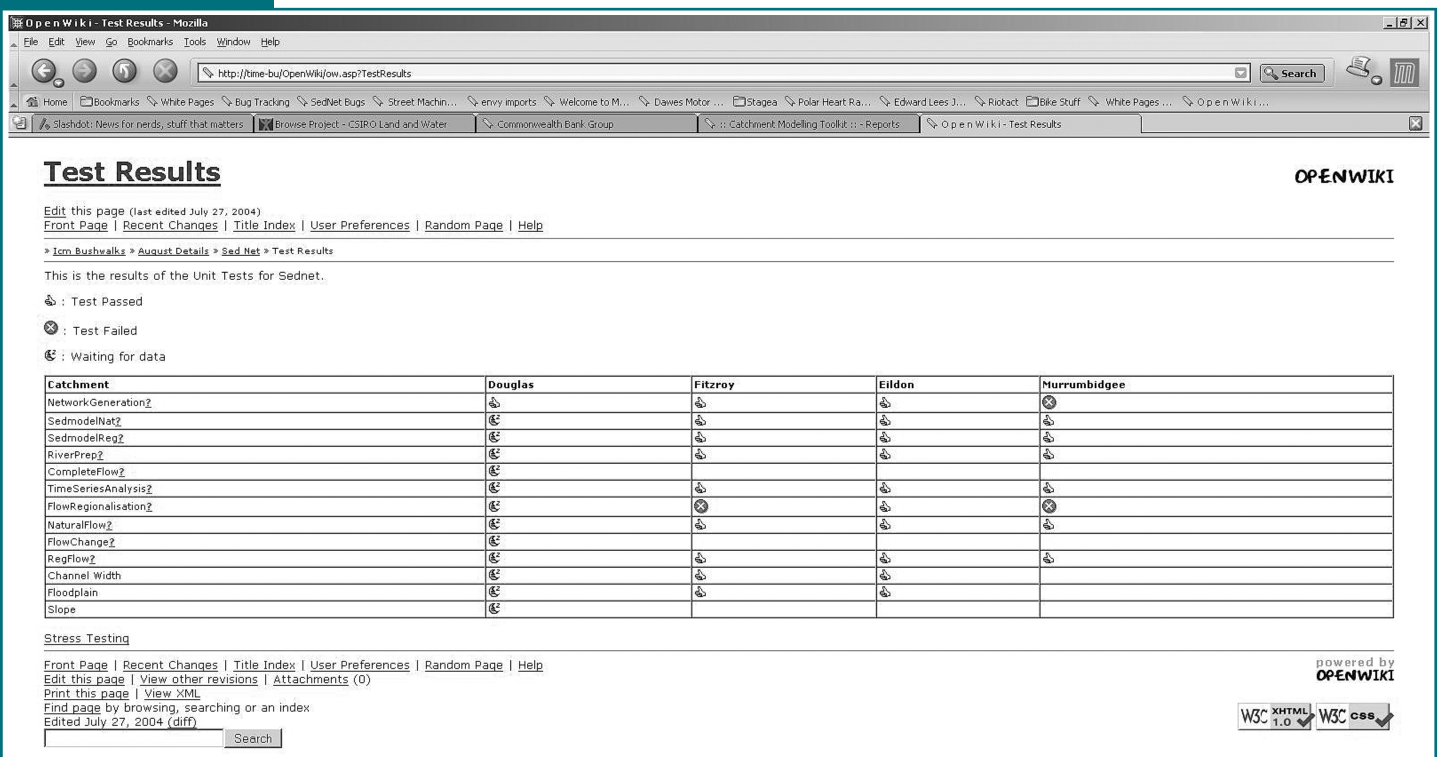

Figure 2.1 Example of unit tests published on internal website

PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by John Tisdell

Adoption of Mwater: the CRC experimental economics platform

Background - water market experiments and demonstrations using Mwater

Program 3 has developed a platform, Mwater, for conducting experiments and field demonstrations of water markets. Over the years, industry demonstrations of the methodology have been conducted in Brisbane, Sydney, Canberra, Melbourne and Tatura. There has been strong interest by government agencies and water authorities in the potential application of the platform and the application of experimental economic methods in general to problems of water resource management.

Market mechanisms project - recharge credit trade scheme for salinity

CSIRO Ecosystem Services is using the CRC experimental economics platform to study alternate market mechanisms for overcoming downstream salinity problems. Their project is a Commonwealth market-based instruments pilot project. This project seeks to develop and apply a market-based instrument that will engage the community within the upper Bet Bet catchment in north central Victoria in farm-based activities that substantially reduce salinity impacts of dryland farming. The proposed approach is a recharge credit trade scheme.

In the scheme, farmers will contract to modify production in ways that reduce recharge, for example, by planting perennial pasture or trees. The contracts will be designed to create opportunities for landholders to generate tradeable recharge credits by offering payments of sufficient magnitude to encourage participation.

Expected outcomes from recharge scheme

It is expected that actual recharge outcomes will vary from the levels planned at the time landholders enter into contracts, with variations due to climate, other natural causes, and management skill in ways that depend on the riskiness of strategies chosen. The recharge reduction outcome from actual practices undertaken will be audited using crop water modelling and on-ground measurement of leaf area index and groundcover. Each farmer will then be assigned credits or debits calculated on the basis of actual recharge reduction relative to their recharge goal. A credit trading round will take place at the end of the pilot year. Credits and debits will be exchanged until all farmers cease to trade voluntarily. To meet their recharge credit levels, farmers will be able to combine recharge reduction achieved by farm management decisions and purchased credits.

Field experiments project

CSIRO Ecosystem Services and CSIRO Land and Water are also using Mwater to conduct field experiments in their pilot project 'Tradable recharge credits in Coleambally Irrigation Area'. The pilot is a joint project between CSIRO, Coleambally Irrigation Cooperative Limited (CICL) and the BDA Group. The pilot is operating in the Coleambally Irrigation Area in the Lachlan-Murrumbidgee NAP region and involves irrigators, CICL, CSIRO and government agencies.

- Costs from salinity

  Irrigated agriculture in Australia often leads to recharge of shared groundwater systems causing saline shallow watertables and soil salinity. In turn, these biophysical impacts impose costs, including reduced agricultural productivity, damage to ecosystems and degradation of local and off-site infrastructure costs passed on to irrigators and other members of the community. Where these costs are external to landowners they are not fully included in their farm management decisions.

- Cap and trade

  A cap and trade based market-based instrument (MBI) is one option for improving the management of the external impacts of irrigation agriculture. Capping the amount of water recharging the shared aquifers will internalise costs. Apportioning the cap amongst individuals with appropriate support institutions creates individual incentives to reduce recharge. Irrigators may reduce their costs of meeting their share of the cap by incorporating perennial vegetation or engineered solutions, changing their management to reduce recharge via crop rotations, or by changes to irrigation technology or purchasing these changes from other landholders.

  Key outcomes are anticipated to include increased agricultural production, environmental protection into the future within the region, and environmental benefits beyond the region through reduced salt accessions to Billabong Creek and the Murray-Darling system.

  Key risks include: insufficient farm scale knowledge; potentially few viable strategies to create recharge credits; and, changes to farmer expectations, and

NEW TECHNICAL REPORT

Nature, Preparation and Use of Water Accounts in Australia

By
Manfred Lenzen

Technical Report 04/2

This report on the nature and use of water accounts reviews major research activities and outcomes in this important area, especially the work carried out at the Australian Bureau of Statistics, CSIRO and University of Sydney in Australia. The report outlines the methodology to integrate water accounts into input-output transaction tables for water multiplier calculations, and highlights the data-intensive nature of input-output analysis and spatial issues associated with regional water accounts and input-output tables.

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.pdf download from www.catchment.crc.org.au/publications

willingness to participate due to both external factors (such as the Living Murray Initiative) and adverse climatic conditions.

The potential for developing a recharge trading scheme has been discussed for some time in the region. The need for action is clear to CICL, however the mechanisms for successful trading have not been developed.

CRC Program recent work

Over the last few weeks John Tisdell, CRC for Catchment Hydrology Program Leader, has been travelling with the project staff conducting field experiments at Yanco with Coleambally irrigation farmers and at Beaufort, Victoria with Bet Bet farmers.

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PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Matt Francey, Hugh Duncan, Ana Deletic, Tim Fletcher

In pursuit of the Holy Grail - attempts to improve modelling of pollutant loads in urban runoff

Introduction

This article describes a model which is aimed at predicting pollutant loads in urban runoff.

The prediction of stormwater quality has proven to be an elusive goal. Reviews of available models have consistently stated that no model is best for every situation, complex models are difficult to verify and calibrate, and that even the most physically based models contain high levels of uncertainty (Huber & Heaney 1980; Bertrand-Krajewski *et al.* 1993; Ahyerre *et al.* 1998).

Duncan (1995), in a review of urban stormwater processes, notes the various methods of representing rainfall intensity in stormwater quality modelling and proposes a simplified approach based on cumulative rainfall intensity, representing the ongoing input of energy through raindrop impact.

Model description

In this study, the approach of Duncan (1995), tested by Vaze and Chiew (2003), which used a power of the intensity summed over short time-steps, is proposed to represent the total energy supplied through rainfall. The main hypotheses are that there is always material available for wash-off, so build-up need not be modelled, and that the wash-off is governed primarily by rainfall intensity. The equation given previously may be expressed in the following form to give both the total load of a pollutant over a storm event and the pollutant flux within an event at a given site:

$$\text{Load} = W \sum_{i=1}^{n} I^b$$

where Load is the load of pollutant per unit surface area produced over the period of interest, I is rainfall intensity measured at short time periods (6 minutes or less), n is the number of equal time intervals for which I was measured over the period of interest, W is a calibration coefficient dependent on pollutant and location, and b is a calibration coefficient dependent only on the pollutant. The novelty in this approach is

Table 4.1. Data sets used in the study (Vaze & Chiew, 2003; Deletic, 1998).

Catchment	Size (ha)	Land-use	No. of events	Pollutants	Comments on monitoring
Blackburn Lake, Melbourne, Aust.	221	Mixed urban	34	TSS, TN, TP	TSS measured directly
Ruffeys Creek, Melbourne, Aust.	106	Residential	11	TSS, TN, TP	TSS measured directly
Gilby Road, Melbourne, Aust.	28.2	Commercial	10	TSS, TN, TP	TSS measured directly
Lund, Sweden	0.027	Car park	69	TSS	TSS measured by site calibrated turbidimeter
Belgrade, Yugoslavia	0.021	Asphalt street	23	TSS	as in Lund

that the total event load is a function of the detailed rainfall intensity pattern during an event, rather than a single intensity parameter (e.g. maximum or average rainfall intensity) characterising the event.

Model application

The model is introduced here using data from the Blackburn Lake catchment in Melbourne, Australia. It is then tested at four additional sites, two more in Melbourne, and in Lund, Sweden, and Belgrade, Yugoslavia. Summary information for these five catchments is given in Table 4.1.

Results and discussion

The relationship between event rainfall and event runoff is well known (Figure 4.1). Runoff volume increases with event rainfall, more slowly at low rainfalls when all runoff is from effective impervious area, and more steeply at high rainfalls when pervious areas and unconnected impervious areas also contribute to runoff. The effective impervious fraction may be estimated from a plot of this kind (Chiew & McMahon, 1998). A straight line fitted to the data typically shows a non-zero intercept, but nevertheless a satisfactory coefficient of determination (R^2). The assumption of a zero intercept leads to the well known rational formula, in which runoff volume is a simple ratio of rainfall volume.

Event pollutant load is also influenced by event rainfall, but the relationship is less satisfactory, as pollutant concentration is not constant during an event. For most pollutants of interest the concentration increases during storm runoff, but pollutants associated with baseflow may show a decrease. Figure 4.2 shows event loads of total suspended solids (TSS).

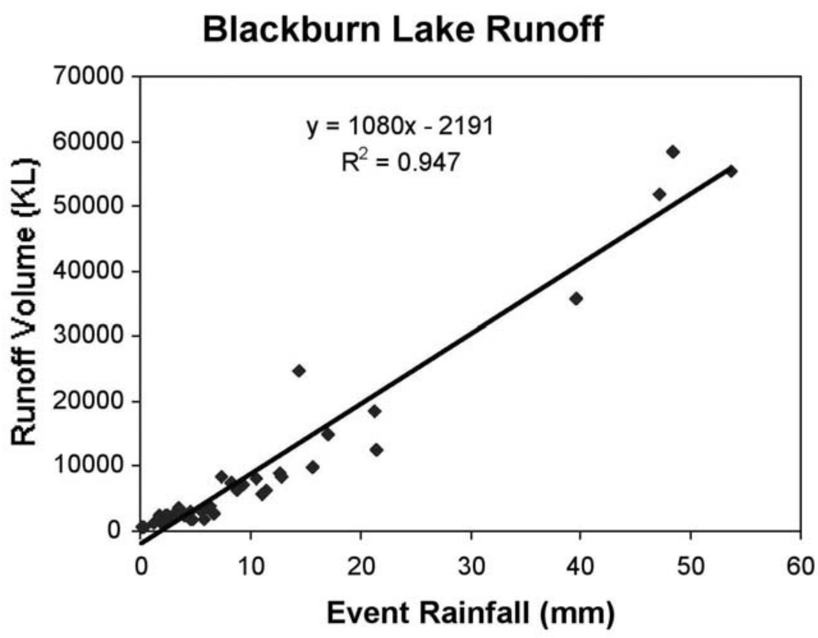

Figure 4.1. Blackburn Lake runoff volume vs. event rainfall.

NEW TECHNICAL REPORT

Integrated Stormwater Treatment and Re-use Systems - Inventory of Australian Practice

By
Belinda Hatt
Ana Deletic
Tim Fletcher

Technical Report 04/1

The aim of this research was to develop an inventory of technologies for the collection, treatment, storage, and distribution of general urban stormwater runoff and, where current knowledge allows, provide interim guidance on stormwater re-use implementation.

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

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

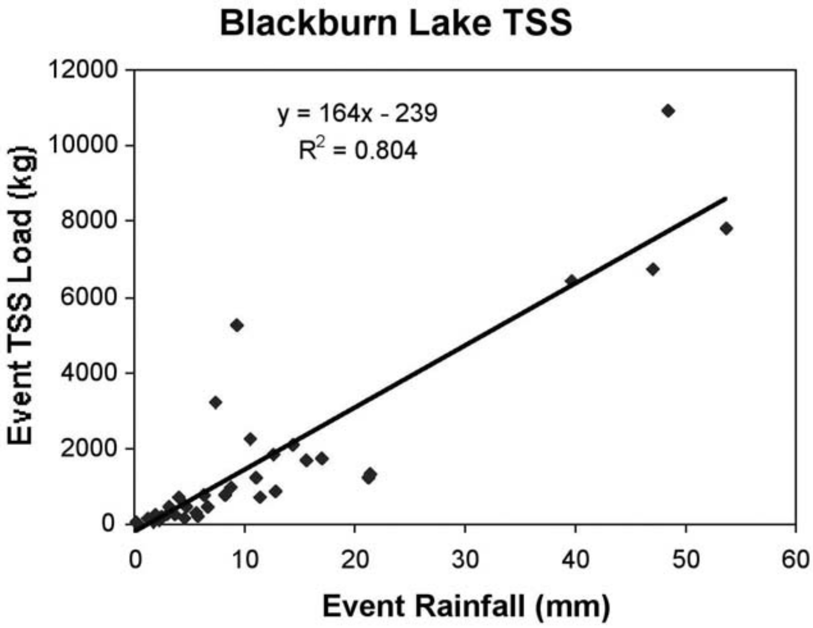

Figure 4.2. Blackburn Lake TSS load vs. event rainfall.

If we now replace event rainfall volume with a measure of event rainfall energy using the function given by Equation 1, the fit to pollutant load is greatly improved (Figure 4.3). The exponent b (1.9 in this case), has been optimised by performing the regression with a range of b, and choosing the case with the highest R2. The coefficient W may be derived from the regression gradient.

Similar results have been obtained at other sites. Figures 4.4 and 4.5 show preliminary results from two other urban catchments in Melbourne. Monitoring only commenced recently at these sites so sample sizes are small, and the single large event recorded at Gilby Road distorts the coefficient of determination. Nevertheless, relationships of the same general form are clearly apparent.

Figures 6 and 7 show relationships for total phosphorus (TP) and total nitrogen (TN) respectively, using the larger data set from Blackburn Lake. Relationships of the same form are again present, although the exponent b appears to be different for each water quality parameter.

The results for all sites are summarised in Table 4.2. Columns headed R^2 of ΣI^b give the coefficient of determination for the optimum exponent b at each site.

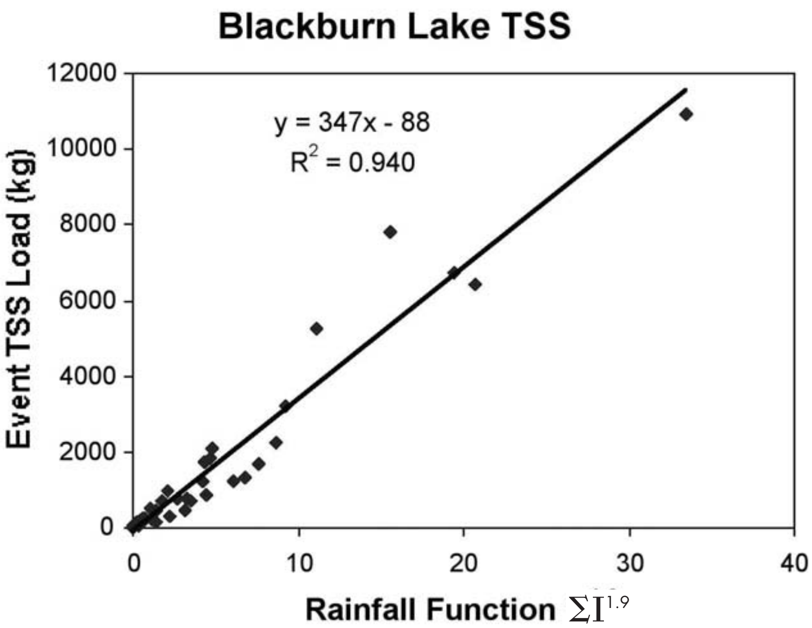

Figure 4.3. Blackburn Lake TSS load vs. rainfall function.

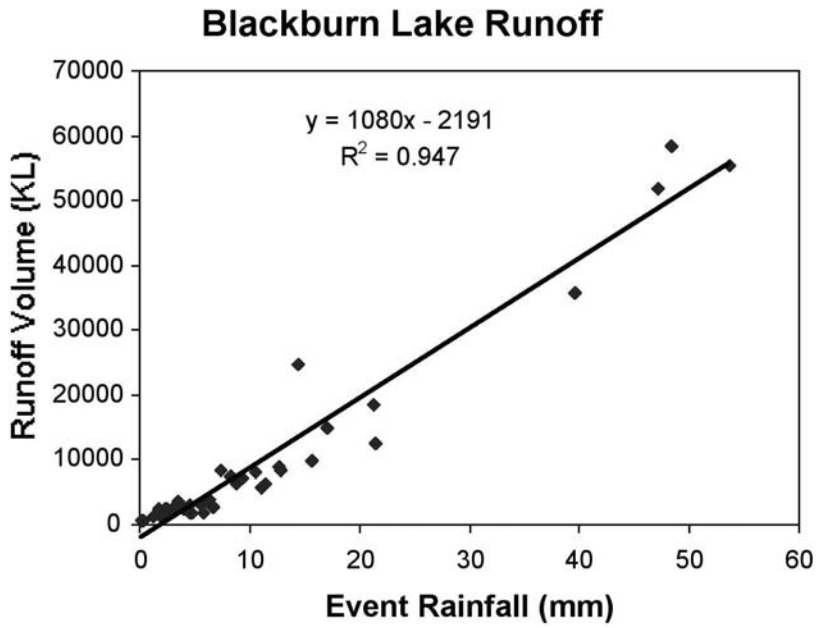

Figure 4.4. Ruffeys Creek TSS load vs. rainfall function (p-value of the regression (1%).

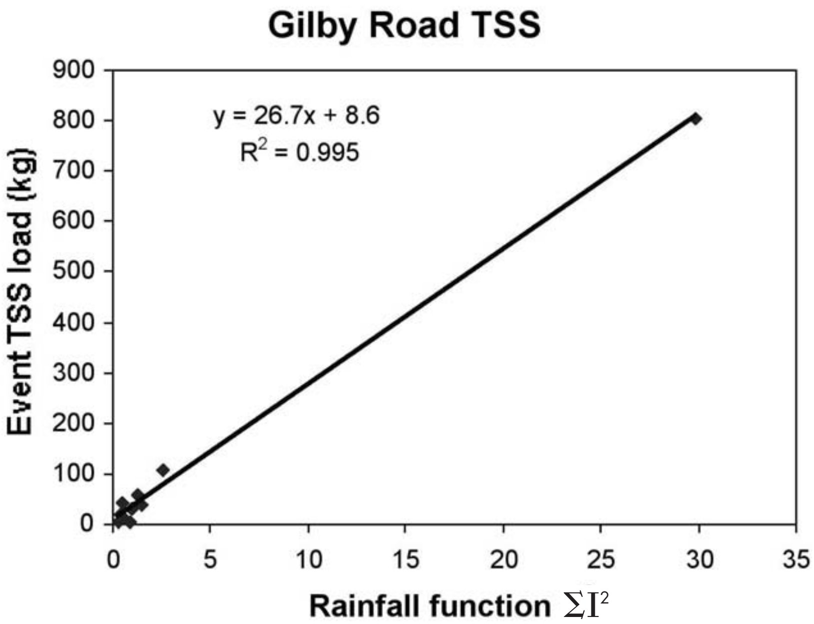

Figure 4.5. Gilby Road TSS load vs. rainfall function (p-value of the regression is (1%).

Columns headed R^2 of ΣI give the coefficient of determination at each site for b = 1. When b = 1, ΣI becomes simply the total event rainfall. As noted above, the correlations at the Gilby Road site have been distorted by the presence of a single large event in a small sample size.

A number of points may be noted. Firstly, the correlation is always improved, and in some cases greatly improved, by optimising the exponent b. This suggests that the pollutant load washed off a catchment may indeed be determined more by rainfall energy than by rainfall volume. It should be noted that rainfall energy physically affects overland flow much more than concentrated or channel flow. The energy input allows particles to be held in suspension until they reach a concentrated flow path, where flow energy becomes much more important.

The results presented here are based on fairly limited data, but even so the technique shows considerable promise. To further develop the method, and to relate the two fitted parameters to land use and pollutant type, eight new catchments have recently been established in Melbourne. They range in size from 0.05 ha to 186 ha, and cover a range of surface types (roofs, roads, mixed)

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.

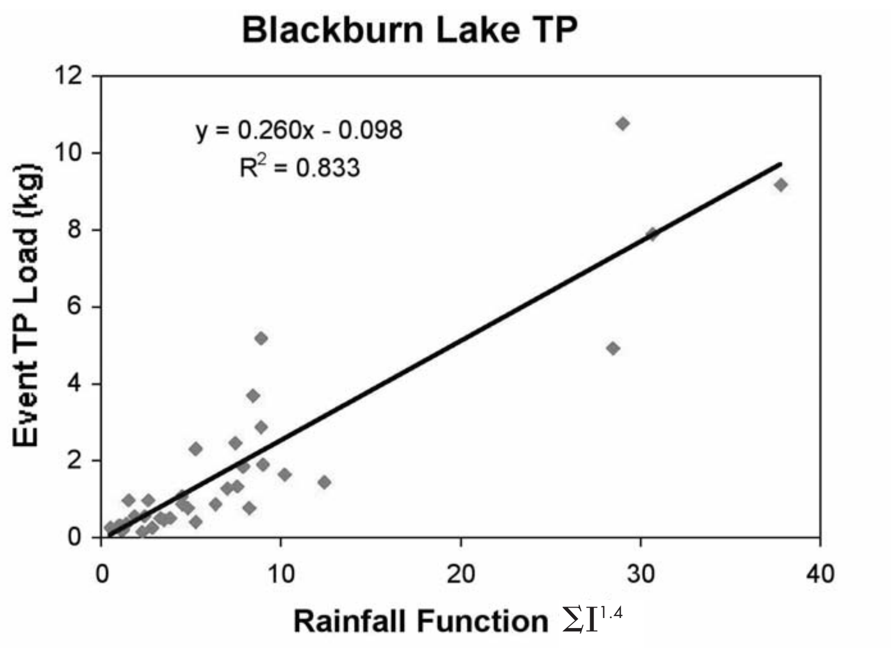

Figure 4.6. Blackburn Lake TP load vs. rainfall function.

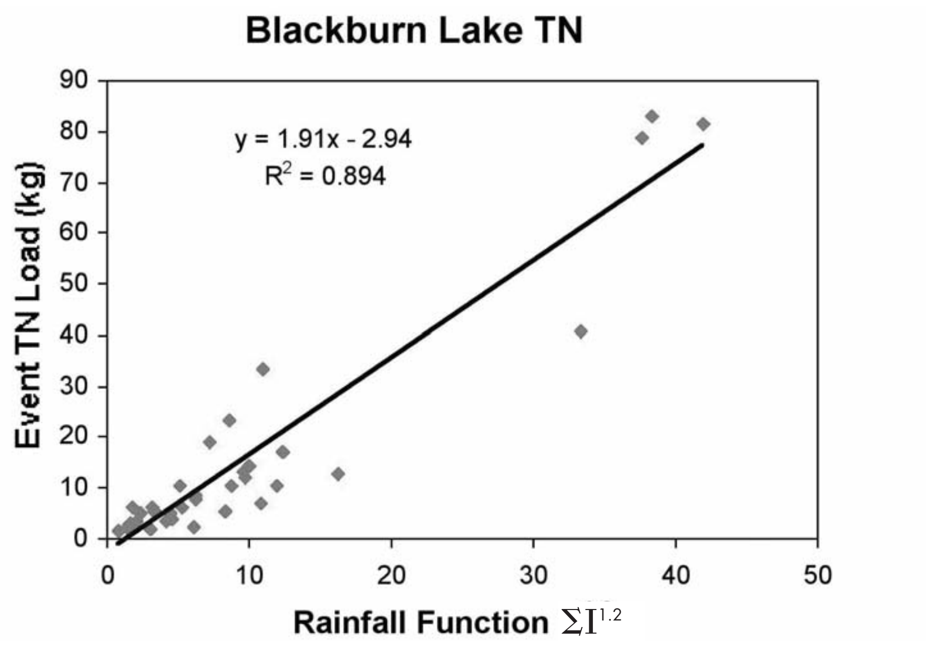

Figure 4.7. Blackburn Lake TN load vs. rainfall function.

Table 4.2. Correlation of pollutant loads with rainfall function and rainfall volume.

Pollutant/Catchment	TSS		TP		TN	
	R^2 of ΣI^b	R^2 of ΣI	R^2 of ΣI^b	R^2 of ΣI	R^2 of ΣI^b	R^2 of ΣI
Blackburn Lake	0.94	0.80	0.83	0.82	0.89	0.89
Ruffeys Creek	0.96	0.22	0.77	0.10	0.76	0.35
Gilby Road	0.99	0.95	0.99	0.97	0.99	0.98
Lund	0.53	0.46	-	-	-	-
Belgrade	0.42	0.41	-	-	-	-

and land uses (industrial, commercial, residential, mixed urban). It is also proposed to test the procedure on other data sets available through the technical literature.

Conclusions

A simple formulation relating pollutant load in a runoff event to rainfall in short time intervals through the event shows promise for predicting urban runoff loads (this is true for at least Melbourne metropolitan catchments). Physically, the procedure relates washoff load to rainfall energy input to overland flow. Algebraically, the equation is a generalised form of the well known Rational Formula. The model is very simple and does not require a large number of calibration coefficients (only two for each site and each pollutant).

Further work

The model will be tested and improved further. An intention is also to model pollution distribution within events (produce pollutographs). In 2003, eight new catchments (of very different size, imperviousness and land use) were established in Melbourne to monitor TSS, TN, TP, PAHs, heavy metals, and particle size distribution. The plan is to collect data on 50 events at each site. However, the model will also be tested on the data sets from outside Australia.

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CATCHMENT MODELLING SCHOOL 2005

The first preparations are now being made for another Catchment Modelling School in 2005.

After the success of the School earlier this year when over 300 participants filled over 500 workshop places, the CRC is investigating possibilities of hosting a one week School in both Sydney and Brisbane during May 2005.

Further details will be made available as they are confirmed.

For further information contact david.perry@eng.monash.edu.au

PROGRAM 5

CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Francis Chiew

Public release of TREND

Overview of TREND

TREND is a model/software product that can be downloaded from the CRC's Catchment Modelling Toolkit website www.toolkit.net.au. TREND is designed for hydrologists, environmental scientists, consultants and researchers to facilitate statistical testing for trend, change and randomness in hydrological and other time series data.

TREND has twelve statistical tests:

- Mann-Kendall (non-parametric test for trend)
- Spearman's Rho (nonparametric test for trend)
- Linear Regression (parametric test for trend)
- Distribution-Free CUSUM (non-parametric test for step jump in mean)
- Cumulative Deviation (parametric test for step jump in mean)
- Worsley Likelihood Ratio (parametric test for step jump in mean)
- Rank-Sum (non-parametric test for difference in median from two data periods)
- Student's t (parametric test for difference in mean from two data periods)
- Median Crossing (non-parametric test for randomness)
- Turning Points (non-parametric test for randomness)
- Rank Difference (non-parametric test for randomness)
- Autocorrelation (parametric test for randomness).

TREND requires a continuous time series as input data. TREND displays as an output the test statistic, the critical values of the test statistic at $\alpha = 0.01$, $\alpha = 0.05$ and $\alpha = 0.1$ significance levels (from statistical tables and from resampling analysis in TREND), and a statement of the test result, for all the statistical tests selected by the user.

Basis of statistical tests

The twelve statistical tests are based on the WMO/UNESCO Expert Workshop on Trend/Change Detection and on the CRC for Catchment Hydrology publication "Hydrological Recipes". The tests are robust and relatively easy to understand. The user can gain a good understanding of the tests by following the descriptions in the User Guide and examples provided in an Excel spreadsheet. The User Guide and Excel spreadsheet of the statistical tests can be downloaded from the TREND homepage (www.toolkit.net.au/trend). The User Guide also provides an overview of the basic concepts in statistical testing and types of statistical tests.

Features of TREND

- TREND is easy to use and runs quickly from a PC (screen captures in Figure 5.1 show some examples of the TREND user interface).
- TREND supports various time series data input formats.
- TREND provides a simple statement of the test result.
- TREND displays the test statistic value and critical values for various statistical significance levels.
- TREND performs resampling analysis to determine critical test statistic values.
- TREND allows easy retrieval of test results.

Cautionary words and advice on using TREND

The statistical tests in TREND are only valid if the time series data is not serially correlated. Most (but not all) time series data with time steps shorter than the annual time step are serially correlated. The Autocorrelation test (one of the tests in TREND) can be used to test if the time series data is serially correlated.

Users are strongly encouraged to carry out an exploratory data analysis (EDA) before using TREND. EDA involves using graphs to explore, understand and present data. EDA allows much greater appreciation of the features in the data than summary statistics or statistical significance levels. Outliers and obvious errors in the data can also be detected through EDA. A well-conducted EDA may eliminate the need for a formal statistical analysis. At the very least, the user should view a time series plot of the data (with a trend line fitted to the data) before using TREND.

Users should have a good understanding of the statistical tests and assumptions (see User Guide). Users should also note that a statistical test provides evidence, not proof (if a trend/change is detected, the reason for the trend/change must be investigated). Statistical significance is not the same as importance (e.g., a change may be detected, but the size of the change may be so small that it is of little importance).

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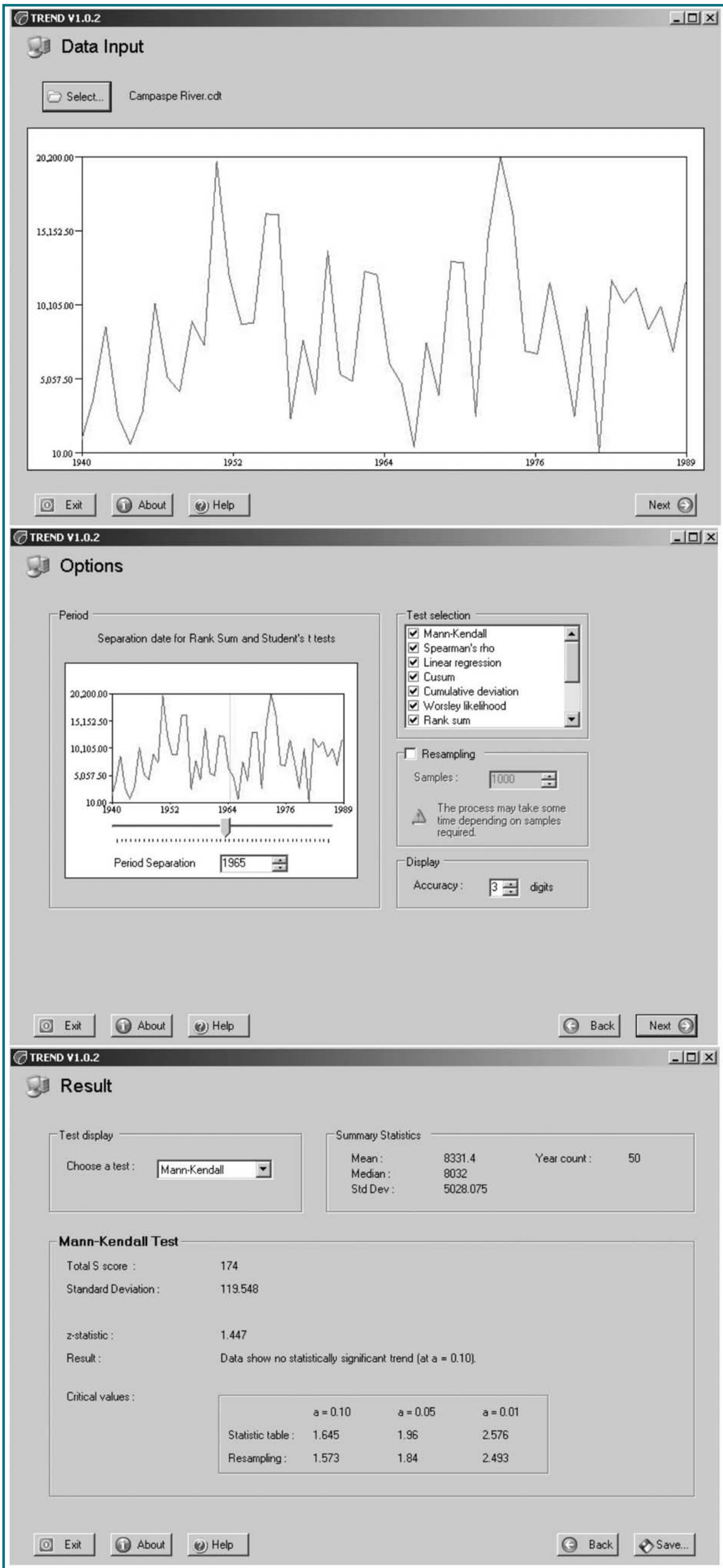

Data Input screen

Test Options screen

Test Result screen

Figure 5.1 Screen captures showing some examples of TREND user interface

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 6

RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Deborah Woods

Dams and Environmental Floods

Introduction

Floods are important hydrologic events generating a range of environmental responses including: input of dead wood into streams; inundation of areas for fish migration and spawning; transport of sediment and nutrients; building and reshaping of river and floodplain form; maintenance of biodiversity; maintenance of riparian ecosystems; and energy and nutrient supply (Haeuber and Michener, 1998; Junk *et al.*, 1989; Michener *et al.*, 1998; Richter and Richter, 2000).

Floods also provide an opportunity for increased wildlife tourism and other recreational activities. Reduction or alteration of flood patterns is likely to affect these responses, potentially degrading and altering ecosystems downstream of a dam. Dams, whilst important to society for water supply, have an impact on the environment and alter flooding patterns downstream of a dam.

I have investigated the impact of 21 large Victorian dams (Figure 6.1) on floods to quantify the effect that the dams have on more frequent flood events (1-10 yr return interval). I undertook this research as part of my Masters thesis on environmental floods. Other aspects of my thesis that are not reported here include an assessment of the capacity for those dams to release environmental floods and a review of success factors and limitations to consider when planning an environmental flood release.

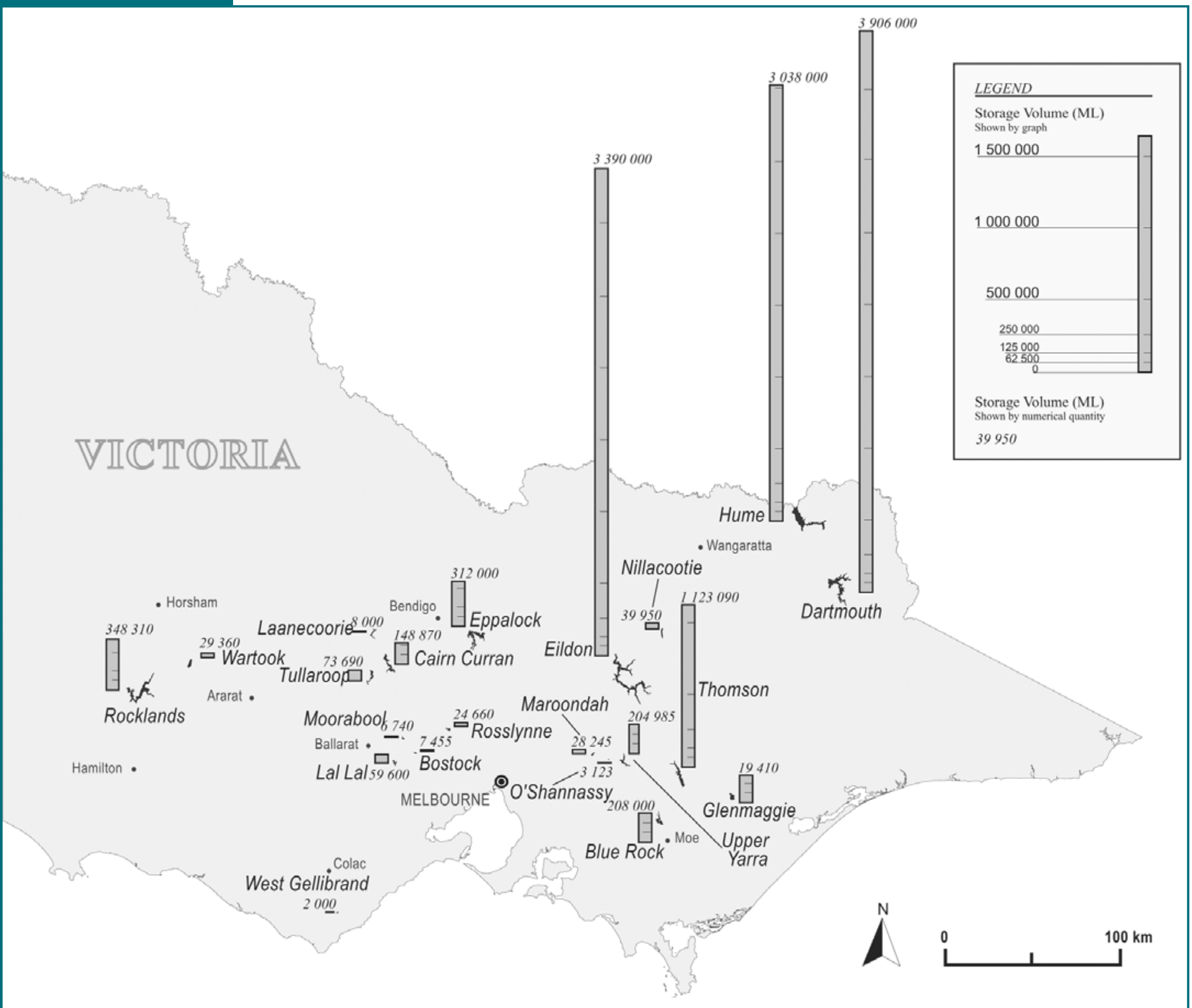

Figure 6.1 Location of the dams across Victoria and storage volumes

Table 6.1 Independent variables selected for use in the multiple regression

Accepted Independent Variable	Rejected Independent Variable
Purpose of dam (water supply, irrigation, hydro or combination of these)	Catchment area
Natural mean annual inflow to dam	Reservoir surface area
Natural mean annual inflow to dam/Catchment area	Storage volume of dam
Number of years to fill storage	50% of Storage volume
Percentage of river length captured by the dam	Storage volume/Catchment area

Table 6.2 Multiple regression results

Dependent Variable	Constant	IV 1	Coeff IV 1	IV 2	Coeff IV 2	Adj R^2	Std Err Est.	P
AVCHFF	-39.95	PURPOSE	4.43	YRSTOFILL	-15.26	0.56	15.87	0.00

Impact of dams on floods

- Natural versus regulated floods

One of the ways I assessed the impact of the dams on downstream flooding patterns was by comparing pre-dam (natural) and post dam (regulated) flood volumes for 1, 2, 5 and 10 year flood return intervals. The length of data used ranged from 11 to 100 years, however the average length of record was 33 years.

All of the rivers with dams assessed had a reduced magnitude of the 1, 2, 5 and 10 year floods after regulation, with the greatest decrease generally being noted for the 1 and 2 year recurrence interval floods. 14 of the 21 regulated rivers show the greatest proportion of change in the one year flood. Average percentage change in the magnitude of the 1, 2, 5, and 10 year recurrence interval floods indicates a strong gradient of change ranging from a decrease of 8.8% for West Gellibrand to a 90% decrease at Rocklands (Figure 6.1). Rivers regulated by Lal Lal, Thomson, Rocklands and Upper Yarra dams show the highest degree of flood change out of all the dams assessed. Studies conducted in Queensland rivers suggest that 80-90% of natural mean annual flow (i.e. 10-20% deviation) is required to minimise risk of environmental degradation (Arthington and Pusey, 2003). While there is no equivalent value available for naturally occurring floods in Victorian rivers, and if the benchmark is applicable to flood change, there is only one river (West Gellibrand River) out of the 21 studied that is not at risk of an altered ecosystem.

- Flood change and other variables

The relationships between flood change and independent variables were tested using multiple regression to determine factors that are associated

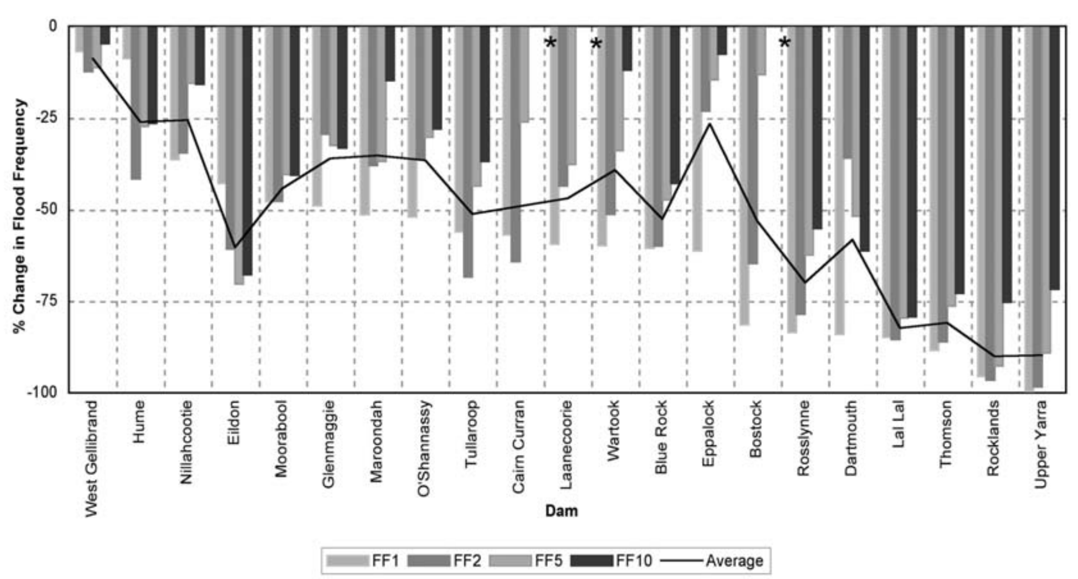

Figure 6.2 Percentage change in the magnitude of the 1, 2, 5 and 10 year flood for 21 Victorian dams, in order of change in 1 ARI, * indicates a positive change

NEW TECHNICAL REPORT

Analysis and Management of Unseasonal Surplus Flows in the Barmah-Millewa Forest

By

Jo Chong

Technical Report 03/2

This report addresses a major threat to the Barmah-Millewa Forest; unseasonal flooding in the summer and autumn, when the forest would normally be dry. Based on analysis of pre-regulation conditions (1908-1929) and current conditions (1980 - 2000), forest flooding has increased from 15.5% of days to 36.5% of days between December and April.

In particular, small, localised floods, which inundate less than 10% of the forest, occur at least eight times more frequently now, than before regulation. Work by others has related these hydrologic changes to tree death and changes in floristic structure in wetlands.

Bound copies of this report are available FREE from the Centre Office while stocks last. Contact Virginia Verrelli on 03 9905 2704 or email crcch@emg.monash.edu.au

This report is also available as a free Adobe .pdf download from www.catchment.crc.org.au/publications

with flood change and their relative strength. The independent variables represent catchment and dam properties that are considered to influence flood change. Initially ten independent variables were identified through a literature review as influencing flood change (Table 6.1). Half of these, including the size of a dam (storage volume) were found to have a high degree of multicollinearity?

- Effects from main variables

  The purpose of the dam and the number of years to fill a dam (a function of the size of the storage divided by natural mean annual flow) were found to explain 56% of the variance in the magnitude of flood change (Table 6.2). Further interrogation of the results indicates that large irrigation dams have a greater influence on the 5 to 10 year floods, as the smaller magnitude floods are made up of releases from dams for irrigation.

A flood comprises several components including magnitude and duration, number of floods in a season/year, and the rate of rise and fall of a flood. The change in floods from dams was expressed as a magnitude, however other components of flood change were assessed as part of my thesis, and are not presented here.

A change in the frequency of flooding is also experienced for many of the rivers regulated by dams. The frequency of the one year flood under regulated conditions now occurs on average every 4.6 years compared with natural conditions, while the five year flood now occurs every 22.9 years (Figure 6.2). Thomson, Upper Yarra, Lal Lal Rocklands and Eildon again showed a high degree of alteration from natural in the recurrence of the one year flood.

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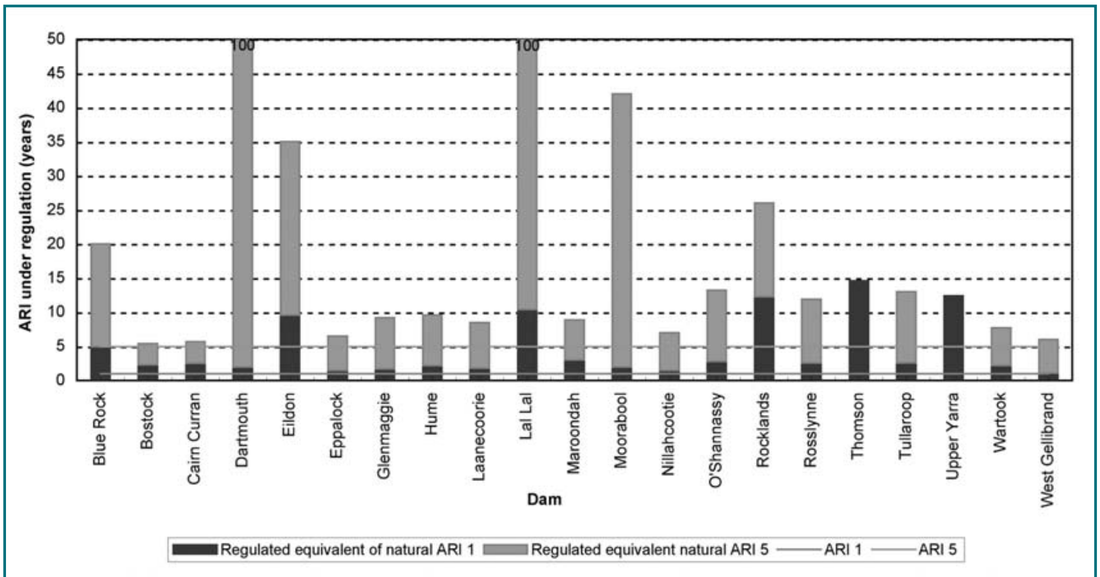

*Figure 6.3 Comparison of the natural 1 and 5 year ARI to regulated ARI, dams shown alphabetically by name, * indicates no value available*

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect - August 2004

At a glance - a summary of this article

This month's article aims to give an overview of recently released CRC products (software and publications) and scheduled future activities.

Introduction

This article outlines:

- TREND software
- Training for TIME software development framework
- New CRC Technical Reports
- On-line copy of 'Spatial Patterns in Catchment Hydrology'
- Errata for Hydrological Recipes
- Catchment Modelling School 2005

First public release of the TREND software

The TREND software is now available to registered members of the Catchment Modelling Toolkit site at http://www.toolkit.net.au/trend. TREND is designed to facilitate statistical testing for trend, change and randomness in hydrological and other time series data. The software is designed for hydrologists, environmental scientists, consultants and researchers to facilitate statistical testing for trend, change and randomness in time series data. The software has twelve statistical tests, based on the WMO/UNESCO Expert Workshop on Trend/Change Detection and the CRC publication "Hydrological Recipes".

TREND is easy to use and is based on statistical tests that are relatively robust and easy to understand. Users can get a good appreciation of the tests by following the descriptions of the statistical tests in the User Guide for TREND and the examples in an Excel spreadsheet. The User Guide and the Excel spreadsheet can also be downloaded from http://www.toolkit.net.au/trend.

Training workshop - Introduction to the TIME framework

The Invisible Modelling Environment (TIME) is a software development framework for creating, testing and delivering environmental simulation models. TIME includes support for the representation, management and visualisation of a variety of data types, as well as support for testing, integrating and calibrating simulation models.

The CRC's Predicting Catchment Behaviour Program team (Program 1) is running an introductory TIME Training Workshop in Canberra on Thursday 16 and Friday 17 September 2004. The workshop will be held at the Pye laboratory, at CSIRO's Black Mountain site. The two-day course will cost $880 or $660 concession and includes a bound copy of the TIME training notes and a CD-ROM containing workshop notes, workshop exercises, the latest release of TIME, sample data and electronic copies of handouts.

For details on the workshop content, requirements and schedule, and what you need to bring, visit http://www.clw.csiro.au/conferences/time/index.html. For details on the TIME Modelling Framework, visit www.toolkit.net.au/time. Online registration can be completed at http://www.clw.csiro.au/forms/timeworkshops/

New CRC Technical Reports

Three new technical reports have just been published by the CRC:

- 'Integrated Stormwater Treatment and Reuse Systems - Inventory of Australian Practice', by Belinda Hatt, Ana Deletic and Tim Fletcher. CRC Technical Report 04/1
- 'Estimating Extractable Soil Moisture Content for Australian Soils' by Tony Ladson, James Lander, Andrew Western and Rodger Grayson. CRC Technical Report 04/3
- 'Water Farms: A review of the physical aspects of water harvesting and runoff enhancement in rural landscapes', by Laura Richardson, Peter Hairsine and Tim Ellis. CRC Technical Report 04/6

These reports are available for downloading from the CRC website or bound copies can be purchased from Virginia Verrelli at the Centre Office for $27.50 including postage, handling and GST. For more information about how to order CRC publications please visit http://www.catchment.crc.org.au/order

Spatial Patterns in Catchment Hydrology available on-line

'Spatial Patterns in Catchment Hydrology - Observations and Modelling', edited by Rodger Grayson and Günter Blöschl, was first published by Cambridge University Press in 2001 but is now out of print. The rights to make the publication available electronically for non-commercial purposes have been given to the authors and it is now available from the CRC website.

'Spatial Patterns in Catchment Hydrology' 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

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

hydrological response. In addition, the introductory chapters review the nature of 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 also a range of water related disciplines such as physical geography, earth sciences, and water resources and hydrology aspects of environmental and civil engineering.

This publication can be downloaded at no cost from the CRC website. Follow the 'Special Publication' link from the CRC's home page at http://www.catchment.crc.org.au.

Hydrological Recipes - publication errata
It is now eight years since 'Hydrological Recipes: Estimation Techniques in Australian Hydrology' was published by the CRC for Catchment Hydrology. 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 errors have been consolidated into an Errata document. The document is available as an Adobe Acrobat pdf from the CRC web site at http://www.catchment.crc.org.au/news. The CRC welcomes any other errors that users are aware of.

Other developments beyond 'Hydrological Recipes'
At this stage there is no plan to produce a new edition of 'Hydrological Recipes', however over the last eight years there have been important developments in several of the areas covered. For example, Topic 4.3, on evapotranspiration estimation for Victoria, has been extended to the whole of Australia and published as maps by the Bureau of Meteorology (see http://www.bom.gov.au/hydro/wr). Work has also continued on Australian versus world hydrology. In other areas such as assessing river condition, there have been major changes in thinking, particularly related to indicators of ecological health. The CRC has also been developing the Catchment Modelling Toolkit software that includes (or will include) several products that are related to topics in 'Hydrological Recipes' and examples are given in the 'news' section of the CRC website.

Catchment Modelling School 2005
Following the popularity and success of the first catchment Modelling School in Melbourne during 9-20 February 2004, preparations are now being made for another School in 2005.

An initial proposal has been made to host a one-week School in both Sydney and Brisbane during May 2005.

Catchword readers will be kept up to date with arrangements as they are confirmed.

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POSTGRADUATES AND THEIR PROJECTS

Marella Rebgetz

I still don't fully understand how I have come to be here, undertaking a PhD through the University of Melbourne in association with the CRC for Catchment Hydrology. Water has been almost a foreign concept to me for much of my life. I grew up on a cattle property in north-west Queensland where we were declared officially drought stricken most years. As the old joke goes, when I first saw rain I thought the heavens were falling in and I fainted in fear, and had to brought around by having a bucket of dust thrown in my face.

After completing a Bachelor of Science degree with honours in physics at James Cook University I worked in a number of different jobs, very few involving science and none involving water. Some years later I returned to university and undertook a Bachelor of Agricultural Engineering through the University of Southern Queensland, during which time I was introduced to the fields of hydrology and irrigation science. Despite my every intention of then finding engineering work in the water field, I spent the next three years in the central Pacific nation of Kiribati teaching maths and physics (having been asked if I could fill in for just one month...). Kiribati is composed of a group of coral atolls, which are effectively long narrow sandbars and hence have no above-ground water holding capacity whatsoever. Trying to describe a river (a prerequisite to teaching hydroelectricity) ranks among my most challenging teaching experiences, along with trying to explain a toaster and the fact that an Australian warship docked off the coast of Nauru (containing the asylum seekers from the Tampa) didn't mean that Australia was invading that (neighbouring) country. Eventually though I decided that it was now or never in terms of a PhD, so here I am...

The overall objective of my research is to assess the potential financial benefits that irrigators can obtain from seasonal climate forecasts. The irrigators would be typically involved in a range of agricultural enterprises, including both cropping and grazing activities. The recent drought, and the potential for even greater climate variability due to climate change, have shown the unreliability of irrigation allocations, even in Victoria. Although a number of studies have shown that the use of seasonal climate forecasts by opportunity croppers may result in higher average gross margins for risk averse irrigators, these have been restrictive in their scope. Perhaps one of the most important limitations was that none of the studies was done in a water trading environment, which has a significant impact on irrigator's choices and decisions.

I will use both serial correlations and teleconnections between the El Niño / Southern Oscillation and streamflow to obtain probabilistic streamflow forecasts. I intend to compare the benefits of these forecasts for a number of different scenarios and risk levels. This will involve optimising the planting / supplementary feed / deficit irrigation / water trading options that return the maximum gross margin for an individual farm under a particular climate forecast. The gross margin that the irrigator would have obtained by following these options under the actual climatic conditions will then be determined.

As I sit here in the middle of a Melbourne winter, with a poster of tropical Kiribati next to my desk, wondering again what led me here, I also ponder how I would explain my research to a people who have never seen a cow or a crop (both require soil to survive), and what I will do when I complete it.

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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 August is:

Tim McVicar

Hello there, my involvement with the CRC for Catchment Hydrology formalised a few years ago when our current Australia Centre for International Agricultural Research (ACIAR) funded project became an associate project of Program 2. In our ACIAR project we are assessing the impacts on the regional hydrology of current (and planned) re-vegetation schemes of the Loess Plateau, China. This area has high erosion rates, and while the positives of re-vegetation in terms of reducing erosion are the aim of the Chinese Central Government policy, the negative impacts of reducing the water yield in a basin that is usually over 100% allocated has, until now, received little attention. Given that northern China experiences variations in climate similar to those of south-east Australia, the 5-to-10 years on from the completion of several large-scale re-vegetation schemes coupled with a dry spell, could cause serious issues. In this project, the Australia site is the middle and upper Murrumbidgee catchments, where we are assessing the impact of land-use change by including time series (reflective and thermal) remote sensing into a regional water balance model.

My interests in the use of time series remote sensing for regional and continental ecohydrology was consolidated when 15 years ago I joined David Jupp's remote sensing group in (the then) CSIRO Division of Water Resources Canberra to research methods of linking time series remote sensing with a water balance model for the Murray-Darling Basin. Since then Divisions have come and gone, we've all got more grey hair, and our aim remains to better understand and manage Australia natural resources. To fully utilise the high spatial density inherent in remote sensing data, and the daily measurement, remains a large part of my research. I am particularly interested in the use of time series remote sensing to assess climate variability, specifically for exceptional circumstances assessment related to drought events.

Since joining CSIRO I've been involved in a range of research projects, recently one of the most exciting has been the development of Web-CATS (CSIRO Avhrr Time Series) with Drs Edward King and Michael Schmidt. The aim of this project is to develop and provide access to the best practice calibrated AVHRR time series data daily from July 1981 until the present.

The following are some useful Web-CATS sites:

http://www.eoc.csiro.au/cats/bpal/AVHRR_GAC/index.eoc (A preliminary example of Web-CATS time series analysis)

http://www.eoc.csiro.au/tech_reps/2004/tr2004_05.pdf (Web-CATS front-end programming)

http://www.eoc.csiro.au/tech_reps/2003/tr2003_04.pdf (AVHRR data explained, with a focus on the Australasian region)

http://www.eoc.csiro.au/tech_reps/2003/tr2003_03.pdf (What AVHRR data can do for Australia's science)

If you want to know more about the ACIAR funded project, please see: http://www.catchment.crc.org.au/associateprojects/aciar/

Also if you want to see the results from a our previous ACIAR funded project please see: http://www.eoc.csiro.au/aciar/ and http://www.eoc.csiro.au/aciar/book/ (the chapters are free to download).

Away from work I enjoy evening strolls with Caroline and our K9 Sinbad, swimming (doing an occasional open water 2km plus swim), surfing, bushwalking, and solving many of the worlds problems over dinner with good friends.

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WHERE ARE THEY NOW?

Report by Avijeet Ramchurn

The last time you caught up with me in *Catchword*, I was completing my Masters in Civil Engineering as an international student at Monash University under the supervision of Erwin Weinmann. My topic was 'Understanding the role of on-farm storages (OFS) in the Regulated Gwydir System'. An outline of the major findings of the project follows in the last section of this article.

Following submission of my thesis in December 2002, I spent a few months waiting for the processing of my permanent residency visa application. This took much longer than expected, and I found myself back in Mauritius in August 2003. It was good to be back home at a time where, for once, water restrictions were not in place. I was happy to catch up with everyone and take it easy, but was seriously hoping that the Australian Immigration Department would get their act together.

Mega Design Ltd, which was my employer prior to my starting the Master's degree, took me up again on a number of civil engineering projects. Most interesting were the feasibility studies carried out for a large dam, in association with SMEC from Australia. For a little while I supervised drilling activities and coordinated the compilation of the technical reports. Finally, my visa came through and I was back in Melbourne in November 2003. An offer from Sinclair Knight Merz came my way, which I thankfully accepted, providing me with the opportunity to work in the field of water resources management in a fantastic group. I am thoroughly enjoying it.

As promised, here is a short outline of my thesis and findings:

My research project was broadly classified under CRC Project 3.1: 'Integration of water balance, climate and economic models'. It addressed the effect of the construction of large on-farm water storage (OFS) in northern New South Wales following the implementation of the Cap on diversions in the Murray-Darling Basin. Such storages or dams, basically designed to harvest large floods, were considered by farmers to be a cheaper alternative to securing a yearly water supply in the long term.

My thesis examined the effect of increasing dam sizes in the Gwydir catchment using the IQQM model of the catchment used at the time by the NSW DLWC (now DIPNR). Four basic types of scenarios were implemented, namely: changes to OFS capacity, changes to runoff harvesting capacity, changes in cotton farmer risk-taking behaviour and finally, the effect of a finer modelling resolution with respect to irrigator representation.

Broad conclusions reached on each aspect investigated were:

- Larger OFS meant more water available to the farmer from opportunistic sources, provided the farmer was careful to minimise losses through evaporation through proper design measures.
- Runoff harvesting did not seem to be a significant factor in the catchment. At the same time though, it was realised that the representation of runoff harvesting in IQQM could be improved in a number of ways.
- Higher risk taking by cotton planters in the Gwydir catchment, through increased planted areas at the beginning of the season, is only likely to pay off if the conditions at the beginning of the season are much wetter than average. In this context, a larger OFS does not necessarily improve the sustainable percentage of cropped area, but can allow a larger absolute area to be sustained as a larger area tends to be planted in the first place.
- Finally, while finer node resolution would not alter overall results, the pattern of modelled water usage in a particular reach could be affected. Hence, a finer node resolution would be particularly necessary near locations where daily to monthly variations in flow could be critical, eg. Wetlands.

It was also found that the fraction of a farmer's entitlement represented by the OFS volume was almost constant through the catchment. This information could be of particular use to water managers when setting water-pricing structures.

Publications resulting from the work are:

Ramchurn A, Weinmann P E and Codner G P (2003). The Role and Impacts of On-Farm Storages in a NSW Irrigation System, Engineers Australia, Proceedings, National Environment Conference 2003, Brisbane 18-20 June, (CD Rom)

Ramchurn, Avijeet, Understand the Role of On-Farm Storages in the regulated Gwydir System, Master of Engineering Science Thesis, 2002

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NEW 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

COOPERATIVE RESEARCH CENTRE FOR

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

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 and Energy, Qld
Southern Rural Water
The University of Melbourne
Grampians Wimmera Mallee Water Authority

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