NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 103 MARCH 2002

A NOTE FROM THE DIRECTOR

Professor
Russell Mein

Inside...

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

NEW DIRECTOR SOUGHT

The CRC is looking for a new Director. I will be stepping down from that position on 30 June 2002, three years into the current seven-year term of the Centre.

My reasons for leaving are mostly personal; retirement will allow me to do the things I've had 'on the list' for a long time now. However, it's also a good time for the CRC, with the further four years of funding providing the opportunity for the new Director to get established and take the Centre forward to its next life.

The position will be widely advertised and I urge anyone who'd like to take a leading role in a talented and dedicated team to consider applying. Information will be available on the CRC web-site, and from John Molloy (CRC Business Manager, 03 9905 5068).

There will be opportunity to look back to provide a personal perspective of my seven-year term as Director in a later *Catchword*, and I plan to do that in June.

Where we are at, and where we are going

In this issue of *Catchword*, Program leaders have been asked to give a summary of progress in the research projects that they manage. The purpose here is to give a broader context to the more detailed articles that appear each month under each Program banner. (We've decided to do this in the March *Catchword* each year from now on, an idea that complements the earlier decision to devote each October issue to the integration of our research - integration of projects between programs, and with those of other research groups).

We are now just over two years into the initial round of core projects, due for completion early next year. Like all three-year projects, outputs tend to be concentrated in the last year of the work, so it is a stimulating time to be in the CRC. In a recent planning workshop, Program Leaders and Focus Catchment Coordinators were asked to forecast the capability we would have at the end of 2002, assuming current projects continue 'on track'. It is fair to say that we were all impressed with what the projected achievements.

The mission of the CRC is to be able to predict the hydrologic impacts of land-use change at whole-of-catchment scale, an aim that requires a new way of thinking for simulation of water driven processes on catchments. Much hydrologic research in the past has concentrated on simulation at the plot (or small catchment) scale, because the variability in, and expense in measuring, hydrologic parameters has made small-scale research more tractable. A different approach is required for simulation of land and stream interactions on large catchments, in order to tackle resource management problems of national importance.

Where are we at? As you will see from the Program reports, the CRC has developed some important building blocks in its first three years on the way to achieving its mission. We have developed and demonstrated software packages that consider both spatial and temporal variability of processes affecting runoff quality and quantity. We are able to measure and represent rainfall variability, a massive improvement on the previous assumptions that rain was uniform around gauges. We know much more about the socio-economic aspects of water diversions from rivers (eg for irrigation), a key component of the utilisation of the streamflow in so many rivers.

Where are we going? The main challenge for the CRC is to integrate more knowledge into our simulation packages. Inclusion of process interactions is one target, so that (for instance) the effect of stream salinity on turbidity and sediment transport can be taken into account. Another is the establishment of linkages with the considerable work being done outside the CRC in resource management; we are looking for synergies and partnerships, not duplication. In all of this, effective communication is a key ingredient.

The CRC is 'on track', but there's a lot to be done to achieve its mission. There is plenty to provide a stimulating challenge for the new Director.

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CRC PUBLICATIONS LIST

Copies of the Publications List are available on request from the Centre Office on 03 9905 2704 or can be downloaded from the CRC website at

www.catchment.crc.org.au

All prices listed include GST, postage and handling.

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

Report by Rodger Grayson and Rob Vertessy

Program Overview

Project 1.2 and the CRC's core goal

In the last issue of *Catchword* we brought you up to date with Project 1.1 (Development of the Catchment Modelling Toolkit). In this issue, we focus on recent progress with Project 1.2 (Scaling Procedures to Support Process-Based Catchment Modelling at Large Scales). But first, let's recall how that project fits into the CRC's core goal, Predicting Catchment Behaviour. If we are to realise the CRC's prime objective of holistic prediction at whole of catchment scale, we need three vital ingredients.

The first is a broad base of good disciplinary science that spans the issues and processes that matter most in catchment management. The various thematic programs of the CRC are each contributing this, with each contributing several models to our predictive arsenal.

The second vital ingredient is a sound catchment modelling framework to serve as the glue that binds these various models and associated data sets together. That has been the quest of Project 1.1, and as you saw in our last article about that project, we have made excellent progress in this area.

The third vital ingredient is a set of practical modelling procedures that can be used to cope with scale mismatches that arise when we try to represent fast and fine scale catchment processes in spatially- and temporally-lumpy models. This is the 'bread and butter' of Project 1.2. So where are we up to with vital ingredient number 3?

Representing variability in hydrologic inputs

Project 1.2 is entering an exciting phase where much of the detailed work over the last two years will begin to find more practical application. A key task for the team this year is to provide advice on where, when and how to represent variability in key parameters and inputs in models, including precipitation, soils and vegetation information. The team is doing this by undertaking a series of numerical experiments using three models of different type. These include SIMHYD (as an example of a simple conceptual model), NETThales (as an example of a fully distributed hydrological model), and VB95 (as an example of a land surface scheme used for water and energy balances in large-scale models – and the model used in the Bureau of Meteorlogy's Numerical Weather Prediction models).

The numerical experiments involve running these models with different approaches to the representation of variability in soils, vegetation and precipitation information, to assess the conditions under which variability is important and how best to represent it in different styles of model. These modelling experiments use information from the Murrumbidgee catchment, and in particular Kyeamba Creek and Adelong Creek, to provide realistic input information and an ability to check simulated response. The compilation of all the data needed to run these models is a time consuming task, but the final data sets should be useful for a number of other projects within the CRC.

The outcomes of these experiments will enable us to summarise, given a particular style of modelling, the best approaches to representing heterogeneity.

Joint work on soil moisture aspects

The Project 1.2 team is also continuing joint work with Project 5.1 (Modelling and forecasting hydroclimate variables in space and time) on testing of the VB95 model against soil moisture and hydrologic flux data collected from a range of sites in Australia and New Zealand to better understand the behaviour of the model and look for avenues to improve its estimation of energy and water fluxes. These data were also used by PhD student David Wilson who is close to submitting his thesis on developing methods to derive realistic spatial patterns of soil moisture from limited information on soils, terrain and average wetness conditions. David's patterns are generated by combining terrain-based predictions with stochastic representations of small-scale processes; the influence of which is also a function of average soil moisture and soil characteristics. These results are useful in modelling studies such as where a range of initial conditions need to be generated.

International contributors

Finally, we would like to acknowledge a number of international visitors contributing to the project at the moment. Sylvia Bozzi and Matteo Spada are Italian students who joined us last month and will finish up in late June. They are working on the numerical experiments of the Kyeamba and Adelong Creek catchments, using the NETThales model. Prof. Fred Ogden from the Department of Civil and Environmental Engineering, University of Connecticut, Storrs USA, is visiting the University of Melbourne for six months working with Andrew Western, Rodger Grayson and Harald Richter (Project 5.1 researcher based at the

Bureau of Meteorology). Fred and CRC colleagues will be involved with work on the numerical experiments with VB95, assessing the relative importance of variability in precipitation, soils, and vegetation information on water and energy fluxes. This is a key part of the work discussed above on illustrating where, when and how we need to worry about different sorts of variability and how to represent it when it is important.

Recent publications

Avid readers wishing to get deeper insights into the work of Project 1.2 will be pleased to learn that a rich literature is emerging from that project. Some of the recent publications from the Project 1.2 team have appeared in 'Hydrological Processes', 'Modsim 2001', Hydrology and Water Resources Symposium July 2002' and other publications. You can follow up on any of these works, or on the project in general, by contacting Rodger Grayson at rbg@unimelb.edu.au or on (03) 8344 6623.

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PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Peter Hairsine and Tim Ellis

Land-use Impacts On Rivers: Program Summary

Introduction and short summary

So, with around one year to go on our current core projects, where is Program 2 at ?

The short summary is that we are in a very productive phase, with products coming out at a rapid rate. The land-use impacts we are describing include changes in water quantity in streams, changes in stream salinity, changes in sediment and nutrients within streams and some changes to the physical habitat of streams. Most of these descriptions are contained, to some degree, in predictive models. The near future will see an intensive phase of testing these models and, in some instances, acquiring new data and building new modules for components, as yet unrepresented, in the program's predictive approach.

Program 2 has four core projects and twelve associated projects. Here I summarise the work of the core projects, including some of relevant output from associated projects. Details of each of the core projects can be found at www.catchment.crc.org./landuseimpacts. A contact list is provided at the end of this article so that you may follow up with the appropriate Project Leader.

Project 2.1

Project 2.1 is making good progress in developing sediment budgets in large catchments. This work is focused around the evaluation of SEDNET, the synoptic sediment movement prediction tool that came out of the National Land and Water Resources Audit work in 2000-01. The project team is evaluating the predictions of where sediment comes from and where it goes to, across the Murrrumbidgee and Goulburn-Broken catchments.

The model considers sediment from sheet and rill, gully and streambank erosion as well as the routing of this material through stream networks and reservoirs. There is an explicit prediction of the expected rate of sediment deposition for each reach of stream in these catchments. This deposition may be of large consequence for the habitat in the stream. Through an AFFA-funded associate project, the team has linked the synoptic sediment behaviour to the impact on bed substrate at specific sites where the condition of the stream has been measured. This step provides one form of validation of the models

NEW TECHNICAL REPORT

CATCHMENT SCALE MODELLING OF RUNOFF, SEDIMENT AND NUTRIENT LOADS FOR THE SOUTH-EAST QUEENSLAND EMSS

by
Francis Chiew
Philip Scanlon
Rob Vertessy
Fred Watson

Report 02/1

In a jointly-funded study, the South East Queensland Regional Water Quality Management Strategy and the CRC developed an Environmental Management Support System (EMSS) to simulate runoff and pollutant movement across the South East Queensland region.

This report summarises a vital part of the research that went into the development of the EMSS. It describes the runoff and pollutant load model used in the EMSS and recommends model parameter values for use in the South East Queensland region.

Copies available through the Centre Office for $27.50.

NEW TECHNICAL REPORT

ESTIMATION OF POLLUTANT CONCENTRATIONS FOR EMSS MODELLING OF THE SOUTH EAST QUEENSLAND REGION

by

Francis Chiew
Philip Scanlon

Report 02/2

In a jointly-funded study, the South East Queensland Regional Water Quality Management Strategy and the CRC developed an Environmental Management Support System (EMSS) to simulate runoff and pollutant movement across the South East Queensland region.

This report summarises a vital part of the research that went into the development of the EMSS. It recommends appropriate pollutant loading values for adoption in the EMSS. The work reported here is based on a very extensive data-mining exercise where the authors scoured reports and databases compiled by several organisations and scientists. In so doing, they have added significant value to work initiated by others.

Copies are available through the Centre Office for $27.50

For further information contact the Centre Office on 03 9905 2704

and also provides the early steps towards predicting the sediment-related downstream impacts of land-use changes on in-stream habitat structure.

Another contribution of the Project 2.1 team has been the successful completion of a sediment budget project for the South East Queensland Regional Water Quality Management Strategy. This associated project identified the major sediment sources to the estuaries of Moreton Bay using a sediment tracer approach. It also provided a test for the SEDNET model in a sub-tropical environment. The measurements were in good agreement with the model predictions.

Project 2.2

Project 2.2 is tackling the issue of pollutant wash-off from hillslopes to streams. The pollutants that are been considered are sediment, nutrients and salt. A focus point of the projects' recent work has been the development of ICMS sediment/nutrient. This model describes the impact of land management measures, such as contour banks and filter strips, upon the delivery of sediment and attached pollutants from hillslopes to stream (see the February 2002 edition of *Catchword* for details). The project is also using the historical plot experiments conducted across NSW and Queensland to test and parameterise models of surface runoff and related sediment transport.

Two PhD projects are an important part of Project 2.2's work. Greg Summerell from NSW DLWC, is investigating the movement of salt out of alluvial landforms into the streams. Greg's work is centred on an intensive field investigation in the Kyeamba Creek Catchment and links with the salinity modeling capabilities of both NSW DLWC and CSIRO Land and Water. Leo Lymburner is investigating the functions of riparian zones across the Fitzroy catchment. By combining field surveys, remote sensing and terrain analysis, Leo is constructing a new generation of methods to assess water-related functions of the riparian vegetation and related management.

Project 2.3

Project 2.3 is concerned with the quantity of water that flows in the streams from catchments and how this is impacted by land-use change. Through attracting external funds from the National Dryland Salinity Program and the Murray-Darling Basin Commission, the project has expanded its scope to consider the related impacts of salt yield and stream salinity. The project continues to make good progress in predicting water quantity and salt movement in streams at the annual and seasonal time step.

The recent development of the concept of "Biophysical capacity to change", in association with the MDBC-funded Catchment Categorisation project, is very exciting. This concept links the accumulated knowledge of groundwater systems from several agencies across the Murray-Darling Basin with the water and salt budgets of the streams. The concept is now being developed for operational purposes in a software product called TERRAPENE. This tool enables catchment managers to make rapid assessments of the gross change in salt and water balance due to land-use change, including reafforestation. The tool permits the consideration of large catchments and scenarios where land-use change is spatially explicit. It does not extend to the problem of where trees should be planted on an individual farm.

The ability of the team to predict water and salt yields has been constrained by the coarse description of land-use. Brendan Christy and Craig Beverly from Victoria's Department of Natural Resources and Environment, Rutherglen, have investigated how different pasture systems partition rainfall into evapotranspiration, runoff and deep drainage. In an upcoming technical report the team summarise the water balance work for these pasture-based land-uses. They also describe how their results are used to determine the actual impact of land-use change on both stream flow and groundwater recharge across the Goulburn-Broken Catchment.

The project has also developed a new scheme for estimating catchment-scale water storage in the soil and regolith. This method uses new methods of terrain analysis in conjunction with widely available data on soil and vegetation attributes. The method provides more realistic estimates of catchment scale water storage than previously available from land resource survey data and has the potential to further improve the prediction of water yields.

Project 2.5

Finally, Project 2.5 concerns the issue of nitrogen and carbon dynamics in riparian zones.

There is now a widespread recognition of the need to minimise the movement of nitrogen from land-based activities to streams, in order to protect downstream water quality and ecosystem health. The Project 2.5 team are investigating the potential of riparian buffer zones for reducing the nitrogen delivered to streams via shallow groundwater flow paths.

The team have installed a network of wells and piezometers in the riparian zone of a small tributary of Coochin Creek near Beerwah in south-east Queensland to monitor water flows and the transport and

transformation of nitrogen. They are particularly interested in measuring the process of denitrification, in which nitrate is transformed by microorganisms to nitrogen gas, since this effectively removes nitrogen from the riparian zone to the atmosphere.

This project is jointly funded by the CRC for Catchment Hydrology and the Coastal CRC. It also has links to development of the South East Queensland Regional Water Quality Management Strategy.

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PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Program Leader: John Tisdell

Overview of the Water Allocation Program

It is now just over half-way through the current round of projects. The Sustainable Water Allocation Program has two core projects and a number of associated projects in its stable.

Project 3.1: 'Integration of water balance, climatic and economic models'

Project 3.1 has developed scoping projects to model the effect of climatic factors on crop planting and watering behaviour, and the effect of climatic and socio-economic factors on trading behaviour. These scoping projects have strong links with a LWRRDC project being undertaken by NSW Dept. Agriculture. The emphasis will be on the understanding of what drives user behaviour (which would normally require interviews).

The research staff and associated PhD students have sub-projects to develop methodologies to calculate water exchange rates, evaluate water balance model efficiency, sensitivity and errors, and integrate hydrologic and climate models and economic indicators. Discussion of exchange rates will incorporate a discussion of property rights as well as third party impacts of trade. Sensitivity analysis is proposed for both IQQM and REALM models; a special version of IQQM is being written by DLWC for this purpose. The outcome will tell us what the important parameters are. The water usage and thus economic outcome is linked to demand models, so that socio-economic indicators will not be just 'bolted-on'; rather feedback loops will be developed to simulate this. There will be a composite of models which in concert will behave in a totally different sensitivity to key parameters; this will require a different approach for dealing with uncertainty and validation. Given ICAM/ANU's work in this area, there is some scope for collaboration.

Project 3..2: 'Enhancement of the water market reform process'

Project 3.2 is building experimental water markets which will provide important insights into alternative water market structures and environmental information. Current literature-based insights indicate experimental economics yields a formalised, replicable approach to assess alternate policy directives, expressed as market outcomes, prior to implementation.

UPCOMING TECHNICAL REPORT

THE DEVELOPMENT OF WATER REFORM IN AUSTRALIA

by

John Tisdell
John Ward
Tony Grudzinski

Report 02/5

The first phase of the CRC Project 3.2 'Enhancement of the Water Market reform Process' was to gather background information on water management in Australia, and water reform and water trading in particular. Part of this important process is to gain an overview of the nature of water, a history of water management in Australia, and current literature on water reform. This report is a summary of that overview and contributes to a greater understanding of water management in Australia and its future.

Copies available from mid April 2002 through the Centre Office for $33.00.

Advance orders welcome.

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 NRE Information Centre in Melbourne. They also stock a wide range of other environmental publications.

AWA Bookshop (virtual)
contact Diane Wiesner
Bookshop Manager
tel: 02 9413 1288
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The second phase of Project 3.2 of the CRC for Catchment Hydrology is to build on existing knowledge to develop market scenarios, trading rules and procedures reflecting mature water markets in 2010 – 2020. Phase two of the project emphasises the development and calibration of methodologies to evaluate the potential economic outcomes of water trading utilising laboratory-based experimentation. In this context, the current phase of Project 3.2 acts as a linkage between the collation and analysis of survey based data in the focus catchments of phase one, and the eventual experimental simulation and analysis of catchment-specific water markets of phase three.

The salient issues revealed by the phase one survey of extant attitudes and opinions on water reform, allocation and trading of irrigators in the Goulburn Broken and Fitzroy catchments are viewed as a primary source of data in establishing an experimental framework. In addition, survey analysis enabled the identification of preference sets of stakeholder groups, including the expectation of and blockages to water reform and subsequent trading in water based entitlements in two of the largest catchments in the eastern states of Australia.

The results from the catchment surveys, in concert with theoretical issues identified from the international literature, have informed the formulation of the experimental framework. Applied treatments reflect prevailing stakeholder attitudes to and knowledge of extant market institutions and water trading, conditioned by issues of distributive equality, social justice and environmental flows. It is proposed that the experimental outcomes will provide a formalised, calibrated and replicable simulation of alternate policy and management directives, applied across jurisdictions, evaluated with a view to eventual practical implementation.

The next twelve months of the program are going to be very exciting for this new program in the CRC for Catchment hydrology.

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PROGRAM 4
URBAN STORMWATER QUALITY

Program Leader
TONY WONG

Report by Tony Wong

Program Overview

Introduction

The purpose of the Urban Stormwater Quality Research Program is to develop urban stormwater management systems to better protect environmental and community values of urban aquatic ecosystems. This requires catchment-wide integration of urban drainage infrastructure planning and design, with elements of urban hydrology, ecologically sustainable land development, land-use planning, urban landscape architecture and asset life-cycle economics.

The focus of research efforts in the Urban Stormwater Quality Program has been to provide industry with:

- the capability to develop and evaluate integrated urban stormwater management strategies at a range of typical spatial scales
- the ability to model the effect of different types of stormwater treatment methods, including setting priorities and locations within a catchment

Development of Communication and Adoption Plan

In conjunction with planning the urban stormwater quality research activities, was the development of the Communication and Adoption Plan to facilitate effective technology transfer and adoption of research findings. In the process of industry consultation, it was apparent that a different research ethos needed to be adopted. The traditional approach to technology transfer, in the form of publications in journals and conferences, will need to be complemented by a more pro-active plan of engaging the industry. We were conscious that it was also necessary for researchers to "put their best science forward" to accommodate an immediate need for technical guidance in stormwater management.

Our communication and adoption strategy for our research outcomes has centred around the development of a decision support system that integrates the outcomes of our research on urban stormwater management techniques.

Research activities

Since January 2000, we have embarked on three types of activities:

- the development of the decision support system,
- the development of training material, and
- fundamental research activities associated with field monitoring, experiments and theoretical development.

Fundamental research based around scientific studies remains the principal activity of the urban stormwater quality research program. A combination of targeted field studies, PhD projects and Associated Projects provide the necessary scientific underpinning of the decision support system and associated training material. Research activities over the past two years have been directed at achieving a better understanding of the following issues:-

i. pollutant generation from differing landuses and catchment characteristics,

ii. performance of stormwater treatment measures, and how it may vary with design specifications

iii. long-term performance of proposed stormwater strategies against water quality standards

iv. resultant impacts on receiving ecosystems, before and after implementation of the proposed stormwater strategy.

Research undertaken at the CRC for Catchment Hydrology has given substantial insights into the majority of the research issues raised above. The issue of ecosystem responses to catchment urbanisation remains an important knowledge gap and is the subject of collaborative research between the CRC for Catchment Hydrology and the CRC for Freshwater Ecology.

Model for Urban Stormwater Improvement Conceptualisation (MUSIC)

The CRC for Catchment Hydrology developed a support system for urban stormwater management - a support system which uses a stochastic watershed modelling approach to predict the generation of stormwater flows and pollutant loads. This system allows urban catchment managers to predict changes to water quality and hydrology resulting from altered land-use, and to develop best-practice stormwater strategies to avoid or ameliorate these changes. The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) is designed to simulate stormwater systems in urban catchments and has the capability to operate at a range of temporal and spatial scales, suitable for catchment areas from 100 km^2 to 0.01 km^2. The modelling time-step can range from 6 minutes to 24 hours to match the spatial scale.

The model was released in March 2001 for beta-testing amongst officers in Brisbane City Council, Melbourne Water Corporation and a number of their consultants. The beta testing period lasted some six months and a Users Forum was convened in October 2001 to gather feedback on the model. The beta-testing of MUSIC has been a resounding success and we commenced work on further refining the model in November 2001. The refinements cover additional features such as the capability to model the effects of stormwater harvesting and reuse schemes on the stormwater quality discharged to receiving waters. The industry release of MUSIC Version 1 is scheduled for May 2002 and will be launched in Melbourne, Adelaide, Canberra, Sydney and Brisbane with half-day seminars on selected research studies presented by CRC researchers.

Communication and Adoption Activities

A total of six five-day shortcourses on the planning and design of stormwater management measures have been conducted since January 2000. They have been very well attended and have been an important element in supporting the industry in changing its focus in urban stormwater management to one that encompasses multiple management objectives – objectives beyond those of stormwater drainage and flood mitigation.

Two training courses on the application of MUSIC were presented to officers from Brisbane City Council, Melbourne Water Corporation and its consultants in April and May 2001. These courses were part of the MUSIC beta-testing process then, but will become available to the industry in 2002.

In addition to the shortcourse and training course outlined above, members of the CRC Urban Stormwater Quality research program have been actively engaging the industry through presentations in seminars and conferences, and leading field-tours of stormwater treatment facilities in Brisbane and Melbourne. The research activities and research outcomes of the program have had wide exposure in the industry nationally, and in some instances internationally, this last two years.

Target Field Studies - Stormwater Quality Monitoring

Since January 2000, the CRC has been supporting the stormwater monitoring efforts of Brisbane City Council in quantifying the stormwater pollutant characteristics in a number of urban catchments of differing land-use. We have developed a set of water quality monitoring protocols that enable stormwater quality constituents to be categorised according to their relative priorities. Different categories of stormwater quality constituents and pollutant characteristics have been established, with the lowest level (Level 1) being the water quality constituents and pollutant characteristics which should be analysed for all samples collected at the monitoring sites.

NEW TECHNICAL REPORT

THE STATUS OF CATCHMENT MODELLING IN AUSTRALIA

by

Frances Marston
Robert Argent
Rob Vertessy
Susan Cuddy
Joel Rahman

Report 02/4

The CRC for Catchment Hydrology is developing a new generation of catchment models and modelling support tools, integrated within a system of software known as the Catchment Modelling Toolkit. The purpose of the Toolkit is to improve the standard and efficiency of catchment modelling, and to provide much-needed enhancements in predictive capability for catchment managers.

This report describes a vital element of the planning underpinning the development of the Toolkit concept. It summarises the results of three different surveys that gauged the opinions of catchment managers, model users and model developers with respect to the status of catchment modelling in Australia.

Copies are available through the Centre Office for $27.50

UPDATED EVAPOTRANSPIRATION AND RAINFALL MAPS FOR AUSTRALIA

Where to get them!

The CRC for Catchment Hydrology and the Bureau of Meteorology have recently completed a project to produce national maps of evapotranspiration for Australia.

The map set is now available for $33 plus postage and packaging.

They can be purchased from:

1. Publications Section, 9th floor, 150 Lonsdale St Melbourne. tel: 03 9669 4000 (main switch) and ask for Publications

OR

2. Bureau Regional Offices (all capital cities) Contact details for each Regional Office are available at http://www.bom.gov.au/inside/contacts.shtml

Information about the climate atlas map sets and the digital map data sets can also be obtained from: National Climate Centre Ph: 03 9669 4072 Email: webclim@bom.gov.au

Technical queries about the evapotranspiration modelling can be referred to Dr Francis Chiew at The University of Melbourne email f.chiew@civag.unimelb.edu.au

Any technical queries about the mapping should be referred to Graham de Hoedt tel 03 9669 4714 email: g.dehoedt@bom.gov.au

Water quality constituents and pollutant characteristics listed in the higher levels (Levels 2 & 3) will only be analysed for a smaller number of selected samples. The protocols have facilitated a consistent basis for water quality sampling and analysis within the program.

Stormwater monitoring in urban catchments is on-going but with progressive modifications to the scope of the activity to better direct the resources. We are focusing more of our efforts at understanding the speciation of pollutants generated from urban catchments.

The stormwater quality results to date have indicated that the pollutant generation rates from urban catchments in Brisbane and Melbourne generally fall within the expected range derived from the previous analysis of world data. Their statistical properties (eg. standard deviation in the log domain, serial correlations and cross correlations) have been used as default parameters in MUSIC.

Field monitoring of stormwater treatment facilities

Field monitoring of stormwater treatment facilities has yet to commence in any substantial manner owing to a number of factors, including the priority given to conducting field experiments in a number of existing stormwater treatment facilities. There has been some dry-weather and wet-weather grab sampling undertaken at a number of Brisbane sites. Urban stormwater runoff entering Native Dog Creek was monitored following a large storm event in January.

Several stormwater treatment systems have been recently constructed in Brisbane (eg. Bridgewater Creek Wetland, Holyand Street Bioretention) and Melbourne (eg. Hampton Park Wetland, retrofitting of Ruffeys Creek Wetland, Lynbrook Bioretention System) and preparations are currently being finalised to commence monitoring the performance of these systems.

Monitoring of the density and growth of plants in the Bridgewater Creek Wetland are being monitored. Aquatic biota are being monitored at Golden Pond, Bridgewater Creek and Native Dog Creek in Brisbane.

Field experiments

A substantial amount of the program resources have been directed toward field experiments at existing stormwater treatment measures. These systems are subjected to controlled hydraulic loading and dosing of suspended solids and nutrients of known characteristics. These field studies have provided much needed data on the performance of these systems and have been reported in technical papers and in previous *Catchword* articles, ie.

- Field experiments in stormwater treatment wetlands [*Catchword* No. 81, March 2000]
- Suspended solids removal in stormwater wetlands: quantifying the role of aquatic macrophytes [*Catchword* No. 90, December 2000]
- Grass swales for stormwater pollution control [*Catchword* No. 96, July 2001]
- Hallam Revisited: Hydraulic efficiency in vegetated and open channels [*Catchword* No. 100, November 2001]

Laboratory techniques are being trialled and developed to quantify biofilm growth (cells and associated extra polysaccharide (EPS)) on gravel substrate infiltration systems [*Catchword* No. 101, December 2001]. Preliminary results indicate extensive EPS development; this could play a major role in trapping very fine particulates.

PhD Projects

PhD projects are an integral component of the activities of the CRC. The urban stormwater quality research program currently supports six PhD projects. Below are brief descriptions of their objectives and current status.

- *Impediments and Opportunities of Sustainable Stormwater Management Schemes* (Sara Lloyd, Monash University) – This project is directed at addressing current impediments to the widespread adoption of Water Sensitive Urban Design by industry. Many of the impediments are related to insufficient quantitative data on the integration of current best practice planning and design principles for stormwater management into land development. Sara is expected to complete her research project in December 2002.

  To date Sara has documented the development, design and construction of the WSUD stages of the Lynbrook Estate [*Catchword* No. 80, February 2000 & *Catchword* No. 87, September 2000], undertaken experiments to measure the performance of the biorentention systems at Lynbrook, and documented maintenance practices and life-cycle costs of a range of stormwater treatment measures.

  Documentation of consumer responses to residential developments incorporating WSUD is near completion (see Associated Project) and Sara has commenced a six-month paired catchment monitoring of the Lynbrook Estate, comparing the hydrologic and water quality responses between a catchment subjected to WSUD to one with a conventional stormwater drainage system.

  Since the commencement of her PhD candidature, Sara has published six technical papers and two technical reports. She is currently preparing a CRC Industry Report on WSUD.

- *The performance of porous pavements on stormwater quantity and quality management* (David Newton, Griffith University) – This project commenced in May 2001 and is directed at studying the rainfall-runoff characteristics of porous pavements and its attributes as a stormwater quality improvement measure. David has completed an extensive literature review of porous pavement technologies and is currently conducting a series of experiments to determine the field capacity of, and evaporation rates from, porous pavements to gain an insight on the volumetric runoff coefficients and storm initial loss of these systems.

  Work to date suggests the particle size of the porous media influences the rate of evaporative losses and storm initial loss. Further experiments on the influence of particle size of the porous media on stormwater quality improvement will also be conducted and a predictive model formulated for determining the hydrologic and water quality effects of porous pavements of differing porous media characteristics. The findings of the research can be directly incorporated into MUSIC.

- *Characterisation of Urban Stormwater Quality* (Muthukumaran Muthukaruppan, The University of Melbourne) – This project commenced in April 2000 and is aimed at studying suspended sediments and associated metal concentrations in urban stormwater. Suspended solids are generally considered as the primary pollutant because they act as carrier of other pollutants like nutrients, heavy metals, toxins and other inorganic and organic material.

  The project initially involves field monitoring of stormwater generated from four urban catchments in Melbourne; two in basaltic geological formation and two in silurian sedimentary geological formation. Laboratory analyses of suspended solids for their particle size distribution, and partitioning of suspended solids into a number of particle size range categories for metals analysis were carried out.

  Preliminary results from the field work were reported in *Catchword* No. 102, February 2002. The sample preparation and analytical techniques developed in the course of this project will be adopted in stormwater monitoring in Brisbane catchments to expand the catchment coverage of this project. Given that contaminants such as nutrients and certain metals (eg. copper) are attached to the finer fractions of suspended sediments, as reported in many studies, their effective removal will require the design of stormwater treatment methods such as ponds and wetlands to target these finer sediments.

  It is envisaged that the principal outcome of this research project will be better targeting of pollutant characteristics in the design of stormwater quality improvement measures. The project is scheduled for completion in June 2003.

- *Nutrient Removal Processes in Constructed Stormwater Wetlands* (Geoff Taylor, Monash University) – This project commenced in June 2001 and builds on extensive research undertaken by the CRC on the operation and performance of constructed wetlands in stormwater quality improvement.

  The project will focus on understanding the various processes affecting the removal and transformation of nutrients in constructed stormwater wetlands operating under highly dynamic hydrologic conditions. To date, the primary focus in the design objectives of stormwater treatment wetlands has been the provision of the physical operating conditions that are conducive to the removal of fine particulates during storm inflow conditions. It is envisaged that improved design features can be incorporated into stormwater treatment wetlands for improved nutrient removal. To do this, it is necessary to first gain a better insight on the various processes, other than the physical removal of fine particulates, that are effective in removing/transforming nutrients in stormwater wetlands.

  Currently, an extensive literature review has been completed and planning for field experiments at the Ruffeys Creek Wetland (Melbourne) is underway.

  Two new postgraduate students (Sarah Johnson, Monash University and Courtney Henderson, Griffith University) have recently commenced their candidature under the CRC scholarship scheme and are currently developing their research topics.

  Kate Browning's PhD research project into the suitability of wetland vegetation (eg Schoenoplectus, Baumea, Phylidrum and Carex) for nutrient removal in treated wastewater systems in gravel bed wetlands has been underway for 18 months. The plants have been cropped twice and yielded high biomass.

Associated Projects

Associated projects are projects which are largely externally-funded but are of direct relevance to the objectives of the CRC. The Urban Stormwater Quality Research Program is involved in four associated projects.

URBAN STORMWATER TECHNICAL REPORT

WATER SENSITIVE URBAN DESIGN IN THE AUSTRALIAN CONTEXT - CONFERENCE SYNTHESIS

by
Sara Lloyd

Report 01/7

In August 2000 a conference was held in Melbourne to highlight and explore the opportunities and impediments to the adoption of Water Sensitive Urban Design (WSUD). WSUD is the term used to describe a new approach to urban planning and design that offers sustainable solutions for the integration of land development and the natural water cycle.

This report collates and summarises the key issues raised at the conference, focusing on the current barriers to the widespread adoption of WSUD principles and offers possible solutions to help overcome both short term and long term issues.

Copies available through the Centre Office for $27.50.

For further information contact the Centre Office on 03 9905 2704

NEW WORKING DOCUMENT

GENERATION OF SPATIALLY AVERAGED DAILY RAINFALLS FOR THE YARRA REGION

by

Lionel Siriwardena
Ratnasingham Srikanthan

Working Document 02/1

This document describes the data preparation and the generation of areal average rainfall for the Yarra catchment.

Two daily rainfall generation models, the Transition Probability Matrix (TPM) model and a modified Wang-Nathan Model (WNM), were used to derive spatially averaged daily rainfall sequences for a region encompassing the Yarra catchment in Victoria, one of the focus catchments in the CRC for Catchment Hydrology. The performance of the two data generation models was evaluated with respect to their ability to preserve various important rainfall characteristics at daily, monthly and annual time scales.

Copies are available through the Centre Office for $22.00.

- *Consumer responses to residential developments incorporating Water Sensitive Urban Design (Project 4.3)*

  This project commenced in June 2001 and is jointly funded by Melbourne Water Corporation and the Urban and Regional Land Corporation of Victoria. The objectives of this project are to identify key attributes of Best Management Practices and Best Planning Practices that will encourage community adoption of WSUD and to quantify the extent to which sustainable development (focusing on WSUD) may influence the buying preference within different market segments.

  This research will provide both qualitative and quantitative data on market preference for and acceptance of WSUD in residential developments and is scheduled for completion in June 2002.

- *Monitoring and evaluation of bioretention systems in Nerang (Project 4.6)*

  This project commenced in March 2001 and is funded by Environment Australia as part of their Stormwater Initiative Scheme and is managed by the Gold Coast City Council.

  A number of bioretention systems have been designed and are currently under construction. Monitoring of their performance is scheduled to commence towards the second half of 2002 and the research will provide performance data on the operation of bioretention systems under a range of hydrologic operational conditions.

- *Monitoring Protocols and Selection Guidance For Primary Stormwater Treatment Measures (Project 4.4)*

  This project commenced in July 2001 and is funded by the Environment Protection Authority of Victoria as part of their Victorian Stormwater Action Plan.

  The project aims to develop industry endorsed performance monitoring protocols for gross pollutant traps (GPTs), conduct detailed performance monitoring on selected GPTs, and establish a database to store monitoring results of treatment performances.

  An outcome of the project is the development of GPT selection guides based on site and catchment conditions, maintenance requirements and costs for stormwater managers throughout Victoria. The project will also establish a web-site to provide up to date stormwater product information to councils. This project is scheduled for completion in June 2003.

- *Monitoring and Evaluation Protocols and Selection Guidance For Non-structural Stormwater Management Measures (Project 4.5)*

  This project is also funded by the Environment Protection Authority of Victoria as part of their Victorian Stormwater Action Plan.

  The project will formulate a set of monitoring protocols and evaluation methods that local councils can adopt in undertaking monitoring and evaluation of the effectiveness of non-structural measures adopted as part of their stormwater management plan.

  The project will also include a case study to test the methodology and protocols developed. The case study will enable the monitoring of structural and non-structural measures implemented in the same sub-catchment, and as a result help councils review the cost effectiveness of the different components of their existing urban stormwater management strategies.

Summary

By May of 2002, the Urban Stormwater Quality Program will have delivered to the industry, through MUSIC, the capability to develop and evaluate integrated urban stormwater management strategies at a range of typical spatial scales, with the ability to model the effect of six key types of stormwater treatment methods. The software has the capability for continuous simulation to support a risk-based approach to target setting and performance evaluation of stormwater treatment measures.

Research activities involving field and laboratory experiments are continuing to underpin the technical basis of MUSIC, together with a number of PhD projects, targeted field monitoring and experiments, and associated projects.

The construction of a number of field-scale stormwater treatment measures in Brisbane and Melbourne has provided the research group with the capability to conduct field-scale water quality treatment experiments. These facilities are also demonstration sites to describe the design, construction and operation of stormwater treatment methods.

The research program has delivered a set of industry training courses in the application of MUSIC, and in water sensitive urban design.

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PROGRAM 5

CLIMATE VARIABILITY

Program Leader

TOM McMAHON

Report by Francis Chiew, Sri Srikanthan and Tom McMahon

Program Overview

Project 5.1 Modelling and Forecasting Hydroclimate Variables in Space and Time

Rainfall models

Two models have been developed in the space-time rainfall study. The first, S_PROG, is a rainstorm nowcasting model that forecasts rainstorm one or two hours ahead (see Dec 2000 *Catchword*). Arrangements are being made for the model to be used in the State forecasting centers. The second, MOTIVATE, is a multi-cascade space-time rainfall model and is available as user-friendly software. It has been calibrated using Melbourne and Sydney data, and can be used to obtain stochastic realisations of design storms. It has been used by Melbourne Water to evaluate the design capacities of its sewerage network (see Sep 2001 *Catchword*).

Numerical weather prediction

In the land surface and weather prediction modelling studies, results have indicated that the Bureau of Meteorology's present numerical weather prediction (NWP) model gives reasonable weather forecasts, but can be improved (see May 2001 *Catchword*).

The forecasts will be used as inputs into catchment models in the CRC for Catchment Hydrology Modelling Toolkit. Research efforts are concentrated on improving the land surface component of the model, particularly in the initialisation of soil moisture. The modelling results will be tested using data from the soil moisture monitoring undertaken by the CRC across the Murrumbidgee River catchment (Jul 2001 *Catchword*). The Murrumbidgee monitoring is now part of the Global Energy and Water Cycle Experiment on the Murray-Darling River Basin.

Seasonal forecasting

In the seasonal forecasting study, a detailed analysis of the teleconnection between El Niño-Southern Oscillation (ENSO) and Australian rainfall and streamflow has been completed. The study indicates when and where rainfall and/or streamflow can be forecast months in advance from the ENSO-hydroclimate relationship, and the serial correlation in streamflow (see Dec 2001 *Catchword*). A non-parametric model for forecasting exceedance probabilities of rainfall and/or streamflow has also been developed and tested using streamflow data across Australia. The seasonal forecasts are invaluable to the management of land and water resources, particularly in Australia where the inter-annual variability in streamflow is higher than in most parts of the world (see June 2000 *Catchword*).

Project 5.2 National Databank of Stochastic Climate and Streamflow Data

Stochastic climate data

Good progress has been made in achieving our overall goal of providing a suite of computer programs to stochastically generate climate data at a site on a daily, monthly and annual basis across Australia (see Dec 1999 *Catchword*). At an annual level, we have compared the Hidden State Markov (HSM) model with the traditional lag-one auto-regressive model for 44 rainfall stations covering the range of Australian climates (see Aug 2001 *Catchword*). When parameter uncertainty is taken into account, both models performed equally well. At a monthly rainfall level we found that the traditional approach of the method of fragments did not perform as well as Sharma and O'Neill's non-parametric model. (A CRC for Catchment Hydrology Technical Report describing this comparison is in press).

Rainfall at-site models

Considerable effort has been put into assessing several daily rainfall at-site models using data at 21 stations. Although more research is required, preliminary assessments suggest that the modified Transition Probability Matrix (TPM) and the Wang-Nathan (WN) models generally performed satisfactorily. Specifically, the TPM model was able to preserve the rainfall depths on solitary wet days better than the WN model, whereas the latter model preserved the monthly correlations better than the TPM model.

To complete the data generation process, we have available a model to stochastically generate daily evaporation and temperature data conditioned on the generated daily rainfall. All the above models will be finalised by the end of 2002 and ready for incorporation into the Toolkit.

Spatial rainfall models

The Project 5.2 team has also been assessing two spatial rainfall models. The first is a random cascade daily model developed by Jothityangkoon and Sivapalan and it is being applied to the Murrumbidgee catchment. The

NEW WORKING DOCUMENT

GENERATION OF ANNUAL RAINFALL DATA FOR AUSTRALIAN STATIONS

by

Ratnasingham Srikanthan
Tom McMahon
Geoff Pegram
George Kuczera
Mark Thyer

Working Document 02/3

The work reported here forms part of CRC Project 5.2 - National Data Bank of Stochastic Climate and Streamflow Models - of the Climate Variability Program. The literature review (CRC Technical Report 00/16) carried out as part of the project recommended an autoregressive time series model or the Hidden State Markov (HSM) model to generate annual rainfall data.

In this working document, these two models are applied to 44 stations located in various parts of Australia. The performance of the models is assessed using a number of basic and other statistics. Based on this, recommendations are made as to the appropriate model for the generation of annual data.

Copies are available through the Centre Office for $22.00.

NEW WORKING DOCUMENT

APPLICATION OF HIDDEN STATE MARKOV MODEL TO AUSTRALIAN ANNUAL RAINFALL DATA

by

Ratnasingham Srikanthan
Mark Thyer
George Kuczera
Tom McMahon

Working Document 02/4

In the past, the stochastic generation of annual data was performed generally with a first order autoregressive model which does not explicitly models the observed long periods of wet and dry periods in the annual data. Though geographers and geomorphologists have observed long cycles or changes in the mean level of rainfall and streamflow, it was not explicitly included in annual stochastic data models until the recent work of Thyer and Kuczera (1999, 2000). The model used is referred to as the hidden state Markov (HSM) model.

The purpose of this study is to apply the HSM model to annual rainfall data from a number of rainfall sites across Australia and identify the the sites where a two-state persistence structure was likely to exist.

Copies are available through the Centre Office for $22.00.

second model, developed by Pegram and Clothier, is being applied to the Yarra catchment and generates rainfall at 10-minute intervals.

This is the first major application of the technique outside South Africa. Radar images as well as daily gauged data are used to calibrate the model. Geoff Pegram spent the past two months collaborating with the 5.2 Project team to install and test the model.

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PROGRAM 6
RIVER RESTORATION

Program Leader
IAN RUTHERFURD

Report by Tony Ladson

Program Overview

Background

There is tremendous enthusiasm to rehabilitate Australian streams, with at least $50 million being spent in Australia per year. Program 6: 'River restoration' aims to provide stream managers with tools, and with an understanding of stream processes, that will lead to more effective expenditure on restoration, and ultimately, better streams. The strength that the Cooperative Research Centre for Catchment Hydrology brings to stream restoration is in the disciplines of hydrology, hydraulics and geomorphology. Plus, we have strong links with ecologists through joint projects with the Cooperative Research Centre for Freshwater Ecology. The river restoration program includes seven projects that focus on two main areas: stream restoration procedures and evaluation; and improved design tools for stream restoration.

Project 6.1

Project 6.1 is about planning and evaluating stream rehabilitation projects. We have completed a scoping study and the Murray-Darling Basin Commission has now commissioned the next stage of this project, which will include experimental riparian restoration. Outcomes will be evaluated using robust experimental designs that include replication, controls and references sites. Dan Borg has been employed at The University of Melbourne to get things started, and is currently undertaking a literature review aimed at developing a conceptual model of riparian restoration and its influence on river processes. This will build on existing modelling work such as that undertaken as part of the National Riparian Zone Project; there are also strong links with Project 6.4.

Project 6.2

The focus of Project 6.2 is on urban streams. Originally it was proposed to restore the hydrology of an urban stream by retro-fitting a retarding basin, and then to improve the water quality by constructing wetlands. Instead, following a review of the literature and existing data and discussions with Melbourne Water and CRC for Freshwater Ecology, this project will focus on water quality improvement first. Our plan is to monitor the performance of a wetland (or wetlands) that have been designed and constructed to improve the water quality. In cooperation with CRC for Catchment Hydrology's Program 4, we are now developing a monitoring program that will be capable of capturing the peak

nutrient concentrations entering a wetland so we can obtain a good estimate of loads and treatment effects.

Project 6.3

The Granite Creeks project (Project 6.3) is researching the restoration of rural streams that have been affected by large sediment inputs. The treatment is to install 'simulated snags' - wooden structures made out of railway sleepers. The experimental design includes replication, control and different treatment sizes. Structures have now been in place for one year. The stream was surveyed at the start of the project and is being progressively resurveyed. Preliminary results show the structures have created pools and the CRC for Freshwater Ecology is now evaluating biological outcomes.

Project 6.4

Project 6.4 is evaluating revegetation with a focus on catchments in south-east Queensland near Nambour, about 120km north of Brisbane. Effects are being studied through comparison of treated sites, where vegetation is being established, sites being with and without riparian vegetation. Monitoring is focussing on three areas.

First, the effect of vegetation on sediment is being assessed through the continuously measured turbidity, which is then related to total suspended solids. Long-term monitoring will be required to detect any effects as vegetation becomes established.

Secondly, we have measured temperature to determine the effect on shading. Preliminary results show that water temperatures in shaded streams can be up to 10^{o}C cooler in summer than cleared streams.

A third component of this research is to assess the effect of flow on five common macrophytes. The ability of macrophytes to resist hydraulic forces is monitored by comparing their abundance through time, with flow data. It is also expected that shading will influence abundance as riparian vegetation becomes established.

Project 6.5

Our fishways project (Project 6.5) is progressing well. A fishways workshop was held last year. The proceedings have been published and will soon be available on the Internet. Fishway design guidelines will be prepared in the second half of 2002. Research students are continuing work on: 1) hydraulics of vertical slot fishways; 2) whether fish physiology or behaviour limits rate of ascent in fishways; and 3) methods to automatically detect and count fish in fishways.

Project 6.6

Work on Project 6.6 is aimed to understand, and predict scour of rehabilitation works. Theoretical analysis and laboratory studies for this project are now complete with the work that Nick Marsh has done for this PhD. We also have an extensive database that documents the performance of existing river management works. The remaining research is to check scour prediction models against results from Project 6.3 where scour is being monitored in Granite Creeks. We have also developed a prototype system for measuring streambed scour in real time and preliminary results suggest the approach is feasible.

Project 6.7

Program 6.7, developing an environmental flow methodology, is a star performer in the Program 6 stable. Mike Stewardson is continuing to refine the "flow events" method, which is now being applied to several Victorian projects.

Recent highlights include:

- Publication of a special issue of the Australian Journal of Water Resources on Environmental Flows: theory, practice and management. This follows from the successful one-day environmental flow seminar held at the Melbourne Zoo on 19 November 2001.
- Application of the 'flow events' method to determination of environmental flows on the Loddon River. This will be an on-going project for the next several months.
- Continuing work on sampling issues associated with environmental flows. Elisa Howes has been appointed as a part-time research assistant to continue this work which already includes measurements on the Merri, Delatite and Loddon Rivers and Diamond, King Parrot, Hoddles, and Boosey Creeks.

Closing comments

We will present updates on many of the projects at the Hydrology and Water Resources Symposium in Melbourne in May 2002 where six papers have been accepted related to activities in the program. We also plan to contribute to an Environmental Flows Workshop to be held in conjunction with the symposium. Overall, our projects are going well and we have an enthusiastic team ready to meet the challenges of the coming year.

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INITIAL CRC REPORT

THE CALCULATION OF STREAMFLOW FROM MEASUREMENTS OF STAGE

by

John Fenton and Bob Keller

Report 01/6

This report is the key output from Project FL3, 'Hydraulic Derivation of Stream Rating Curves', part of the initial CRC's Flood Hydrology Program.

The main aims of the Project were to:

- To improve current methods of converting measured water levels to flow rates, especially for high flows; and
- Thereby to improve the reliability of flood estimates.

The report is divided into two main parts. The first part is a more descriptive presentation that is intended to be able to be read without it being necessary to refer to the second part, which consists of appendices providing technical details, as well as a presentation of the hydraulics of river flow.

Copies available from the Centre Office for $27.50

SPECIAL JOURNAL ISSUE ON ENVIRONMENTAL FLOWS

Australian Journal of Water Resources Environmental Flows - theory, practice and management published by the The Institution of Engineers, Australia.

Guest Editors

Dr Mike Stewardson
Mr Lance Lloyd
Dr Andrew McCowan

This special issue provides eight papers and two technical notes on the subject of environmental flows. Some papers document a selection of presentations at a one-day seminar on environmental flows hosted by IEAust, the River Basin Management Society and the CRC for Catchment Hydrology held in Melbourne last November. Other papers on relevant environmental flow issues are also included.

There is limited availability of this issue. Copies can be purchased through the Centre Office for $27.50 including GST and postage and handling. Contact Virginia Verrelli on 03 9905 2704.

PROGRAM 7
COMMUNICATION AND ADOPTION

Program Leader
DAVID PERRY

Report by David Perry

The Flow on Effect – March 2002

AT A GLANCE – A SUMMARY OF THIS ARTICLE

Brief review of the extent of the CRC's general communication activities. Recent adoption highlights of interest to industry.

The theme of this month's *Catchword* is an update of our research progress. It is appropriate then to briefly review progress in the Communication and Adoption Program. This Program supports the broader communication aims of the CRC and assists Program and Project leaders in planning effective activities to promote adoption.

Communication Activities

Our *Catchword* newsletter, the CRC's website and our events notification database (with over 900 people registered) are our key communication vehicles for general information about our activities. *Catchword* currently has 1218 subscribers of which 802 receive hardcopy and 416 receive an email directing them to the website version. Monitoring our website however suggests that a lot more people access *Catchword* from the website than subscribe to it. For example the November 2002 issue of *Catchword* was downloaded a total of 1735 times during the period from November 2001 to the end of January 2002.

Around 3,000 people per month visit our website of which around 30% visit more than once. Last November, Adobe pdf files were downloaded from the CRC website a total of 8467 times. The files downloaded included issues of *Catchword*, our reports, publications list, seminar and workshop flyers, and our project sheets describing the details of our research. Some of the more popular technical and industry on-line reports are downloaded over 350 times a month.

The total represents only the number of times the files are downloaded and consequently the same user may have downloaded the same file several times, leading to some distortion of the actual figures. Nevertheless it does demonstrate that our website is being regularly utilised, and at a significant level. You may recall that the effectiveness of the website and our other communication activities were addressed by in a review by an independent consultant last year; the results were reported in the August 2001 *Catchword.*

Adoption activities

Whilst 2002 is a busy year in terms of adoption as Projects conclude, there have been some important successes in adoption over recent months. Many of these highlights listed below have been reported in earlier issues of *Catchword*:

- The Interactive Component Modelling System (ICMS) is being used by researchers at the Australian National University to model water quality in the Ben Chiefly Dam Catchment. It is also being used to model water allocation in the Murrumbidgee and Namoi catchments.
- The Environmental Modelling Support System (EMSS) software has been completed and is being used by the CRC and WBM Oceanics to assist the South East Queensland Regional Water Quality Management Strategy. It will be released publicly in the next few weeks.
- The sediment budget model 'SedNet', a product of the National Land and Water Resources Audit, has been further developed by CRC researchers and successfully evaluated in the Brisbane River catchment. SedNet has been applied in the Murrumbidgee catchment and the results presented to DLWC regional staff in a context of 'end-of-valley' targets.
- Water market experiments for testing alternative water market structures and trading scenarios have recently been undertaken with irrigators in the Goulburn-Broken and Murrumbidgee catchments. At the workshops, five years of trading were simulated. Overall, irrigators spoke very positively of the experience. These are the first steps to developing a training program for irrigators to increase their skills and experience in water trading.
- A restricted (developmental) release of the Urban Stormwater Quality Program's model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) resulted in uptake by Melbourne Water, Brisbane City Council and five consultants' companies. The public release of MUSIC will now be in early May 2002 with seminars scheduled for Melbourne, Canberra, Sydney, Brisbane and Adelaide. Keep an eye on future issues of *Catchword* for more information.
- Developments in the use of radar for short-term forecasting (called nowcasting), modelling and design storms, has seen the application of CRC radar-based models in Melbourne and Sydney. The Bureau of Meteorology has wholeheartedly adopted

the nowcasting system S_PROG and is implementing the technology in all capital cities and, eventually, across rural and regional Australia. United Kingdom, New Zealand and Spanish organisations have also expressed interest.

- The Flow Events methodology for designing and optimising environmental flows has been applied in the Broken River and the Snowy River. It is now also being applied in the Loddon River through the work of Mike Stewardson.

I hope that this issue of *Catchword* and the update on our research progress has been valuable. I would appreciate any feedback from our readers as we are considering this 'research progress update' theme for a *Catchword* issue around March / April each year.

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PROGRAM 8

EDUCATION AND TRAINING PROGRAM

Program Leader
JOHN FIEN

Report by John Fien

Program Overview

The CRC's Education and Training Program offers Program and Project Leaders, Focus Catchment Coordinators, researchers and postgraduate students support for a range of skills and activities (Project 8.1). The program also houses a small research project on social learning for public participation and community change (Project 8.2)

Postgraduate student support

Project 8.1: 'Capacity building, education and training' seeks to enhance the research skills and job-readiness of CRC scholars through a coordinated program of professional development and supplementary training activities (within available resources). This is being achieved through regular audits of training needs, an electronic discussion group for postgraduates, regular information sharing and updates concerning opportunities for professional development and CRC-specific training workshops. Altogether, there are some 40 PhD scholars located in all CRC participant universities, CSIRO and some agencies. Student research has strong links with CRC core projects and industry research.

A process has been established to identify and secure suitable industry placement opportunities for PhD scholars to develop their professional competencies, networks and opportunities. Guidelines are available, providing advice to enhance studentship outcomes for both participants and supervisors.

Regular training workshops are also organised to support the personal and professional development of PhD scholars. Topics for workshops in the past year include: written and oral communication, community engagement and multivariate statistics. Coming up in 2002 are workshops on project management and multivariate statistics (again due to popular demand).

Workshop / seminar support

The Communication and Adoption (C&A) Plans developed by CRC researchers identify education and training activities including seminars, short courses and workshops. Program 8 provides assistance to Program Leaders and Focus Catchment Coordinators with these educational activities. This assistance includes workshop planning, promotion and facilitation, and the design of evaluation tools. Program 8 staff are experienced educators and can offer advice to ensure workshops and

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Over 1200 people receive *Catchword* each month.

CONFERENCE PROCEEDINGS

THE THIRD AUSTRALIAN STREAM MANAGEMENT CONFERENCE - THE VALUE OF HEALTHY STREAMS

27-29 August 2001

Brisbane, Queensland

Copies of the recent Stream Management Conference proceedings are now available for sale from the Centre Office.

The 700+ page, two volume set contains over 120 papers. Copies cost $110 (includes GST and postage) and can be ordered by contacting the

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Note: Limited copies of the Second Australian Stream Management Conference ($104.50 including GST and postage) are also available.

seminars are based on sound educational and adult learning principles.

Resources to enhance the workshop facilitation skills of CRC personnel and 'train the trainer' workshops appropriate to the CRC are being provided through a partnership project with the Australian Water Association. A presenter's manual has been prepared and is being disseminated through a series of workshops on the theme of "We All Use Water" in all focus catchments. The first of these was in Shepparton and Sydney in February and March 2002.

Public participation and community change

Three PhD students are working on various aspects of this project (CRC Project 8.2): 'The role of environmental communication in public participation' (Clayton White), 'The influence of volunteerism in catchment associations' (Margaret Gooch) and, 'Community based research in catchment management' (Dana Thomsen). Their research has been reported in previous issues.

The remainder of this article focuses on a study of stakeholder perspectives on catchment management in the Upper Fitzroy Catchment of Central Queensland. The research is being conducted to parallel a similar study of stakeholder perspectives in the lower Fitzroy catchment being conducted by the Coastal CRC through Central Queensland University staff led by Assoc Prof Stewart Lockie.

- Stakeholder perspectives – Upper Fitzroy Catchment

The first phase of the project has seen the compilation and refinement of a stakeholder interview list. This stakeholder list has been constructed to incorporate the stakeholders for the Catchment Hydrology CRC and to complement the research being conducted in the Lower Fitzroy and Port Curtis Catchments with the Coastal CRC. Identification of stakeholders will be an on-going activity during the first phase of research through the method of snowballing. The data collected from these areas will be used to inform existing practices of stakeholder involvement and build an overall conceptual picture of the attitudes, knowledge issues, participation practices and decision-making frameworks for a whole - of-catchment view. Stakeholder details are being gathered and an interview schedule planned to enable the commencement of stakeholder interviews in the early part of 2002. Other activities include the gathering of secondary documentation on stakeholders to supplement the interview data. This has involved examination of existing documentation generated by other project activities within the CRC (e.g. Irrigator and Community Attitudes to Water Allocation and Trading in the Fitzroy Catchment, and the Communication Review by Econnect Communication), documentation from individual stakeholder groups and information on past and current decision-making processes.

- Local collaboration

A stakeholder list for the Upper Fitzroy Catchment has been compiled in cooperation with the Study Area Coordinator and key informants. This list covers stakeholders for each of the six Catchment Hydrology CRC programs and incorporates additional key groups and organisations. These stakeholders have been identified and categorised into five groups: researcher, investor, end-user, beneficiaries and communicators. Interview schedules and logistical arrangements (e.g. vehicle usage) will be devised and finalised early in 2002 and confirmed with the Focus Catchment Coordinator.

- Past research

A better understanding of the stakeholders in the Upper Fitzroy has been built by accessing past research reports (e.g. Capacity of and Opportunity for Farmers and Other Land Mangers to Implement Change in the Fitzroy Catchment (1999), Regional Landholder Survey Report (2000)) and through discussions with the Focus Catchment Coordinator and Department of Natural Resources and Mines staff.

- Linkages with indigenous communities

To build a better understanding and linkages with the Indigenous communities in the Fitzroy Management Area the research team engaged in two activities during October. The first was a four day tour of Aboriginal sites in the Carnarvon, Ka Ka Mundi and Salvator Rosa National Parks guided by local elder, and member of the Fitzroy Basin Elders' Committee, Lindsay Black. The second was a three-day workshop involving the Coastal, Reef and Tourism CRCs together with three Fitzroy Basin Elders' Committee representatives. The workshop focused on interactive exchange with Indigenous people – developing understanding of the different needs, concepts and approaches for Indigenous involvement in research.

- Stakeholder profiles and social maps

At the completion of the first phase, as part of the Strategic Perspective Analysis (SPA), there will be stakeholder profiles and social maps compiled using the interview data and secondary data collected. The interview data and relevant secondary documentation will be transferred into NVIVO software for qualitative analysis, and more in-depth data analysis carried out. This database currently holds all the Port Curtis and Lower Fitzroy data collected to date.

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POSTGRADUATES AND THEIR PROJECTS

Our postgraduate for March is:

Yinbang Bao

Background

Yinbang Bao graduated from Tsinghua Unversity, P.R.China, in 1989 with a Bachelor of Engineering Degree. For the next four years he worked with the Beijing Suman Corporation as an assistant engineer in wastewater treatment design.

In early 1994, Yinbang came to Australia and commenced postgraduate studies in the Dept. of Civil and Environmental Engineering RMIT, graduating with a Master's degree in 1996.

Some years later, he returned to RMIT and commenced PhD studies into the bio-chemical treatment of waste water – this time in the Dept. of Chemical Engineering.
In the second year of these studies, Yinbang decided that land and water issues had a stronger call, and he transferred to The University of Melbourne to join the CRC research team in Program 1:'Predicting Catchment Behaviour'.

Yinbang's PhD project is titled: 'A design method for a conceptual framework for catchment modelling' and is supervised by Dr. Robert Argent and Dr. Andrew W. Western. The work forms part of the CRC activities for Project 1.1: 'Development of a catchment modelling toolkit'.

Project summary

Yinbang's project will build on the knowledge of systems design in software engineering – using it as a technical tool - and the understanding and skills available in catchment hydrology modelling to outline a design method for a conceptual framework for catchment modelling. He is aiming to solve some of the existing issues in the module design and construction of systems frameworks.

The aims of the project are to:

- Review the existing catchment models and find the research issues
- Use system design knowledge to conceptually structure the models
- Analyse the issues of the models' conceptual structures and applications
- Develop a systematic approach to reuse the existing models and build future models.

Project timetable

Yinbang has set the following targets for his work:

- Nov. 2000 – Nov. 2001: literature review and project design including the methodologies and proposals.
- Nov. 2001 – Nov. 2002: project trial and development to achieve a primary example
- Nov. 2002 – Nov. 2003: project application, testing, modification and final documentation.

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SUSTAINABLE WATER ALLOCATION REPORT

IRRIGATOR AND COMMUNITY ATTITUDES TO WATER ALLOCATION AND TRADING IN THE MURRUMBIDGEE CATCHMENT

by
John Tisdell
John Ward
Tony Grudzinski

Report 01/1

This report presents the results of a Land and Water Corporation funded research project aimed at developing an understanding of irrigator and community attitudes to water allocation and trading. This document reports the findings of a survey of irrigators and community members in the Murrumbidgee catchment. The questionnaire elicited attitudes of irrigators and community members to the Council of Australian Governments (COAG) reforms, to temporary and permanent water trading, to the impact and future of water trading, to the role of the water authority in regulating the market and to environmental issues.

Copies available through the Centre Office for $27.50.

CRC PROFILE

Our CRC Profile for March is:

Sergei Schreider

I am a Research Fellow at the Department of Civil Engineering, Monash University and am working on Project 3.1 "Integration of Water Balance, Climatic and Economic Models" within Program 3 "Sustainable Water Allocation".

My undergraduate background is pure (I would say crystal pure) mathematics. I did my diploma in differential topology at Moscow State University. A few years ago I found my thesis among other old documents and tried to read it. I have to confess that this stuff is far beyond my understanding now. After graduation I didn't work a single day as a pure mathematician, however, my student exercises always helped me to learn new, more applicable areas of mathematics, such as numerical methods, statistics, and the optimisation theory.

After graduation I joined the Institute of Physics of the Earth, in Moscow. In 1990 my Department separated from the Institute to form an independent organisation called the International Institute of Mathematical Geophysics. I am proud to keep up my affiliation there. My major research interests during that period were related to seismic processes, earthquake generation mechanics, and risk analysis. In that time I formed my researcher's self-identity and formulated the major question I want to address in my work: 'What is an appropriate formal language to describe the natural processes, and how can it help with an understanding of these processes?' We can use the word 'modelling' here.

After immigration to Australia in 1992, I joined the group led by Professor Tony Jakeman of the Australian National University in Canberra in the Centre for Resource and Environmental Studies, and later the separate Integrated Catchment Assessment and Management Centre (ICAM), at ANU. In 1996 I finished my PhD in hydrology, which I completed under Tony's supervision.

Why did I choose hydrology? I believe that among other geophysical disciplines it provides the best opportunities to validate scientific constructions. Indeed, in seismology no-one can tell you for sure what are the tensions in the hypocentres of an earthquake, located as they may be several kilometres to several hundred kilometres below the land surface. It is very difficult for atmospheric scientists to document the turbulence vortices within a single tornado (remember "Twister"™). In surface hydrology almost all parameters are measurable and, disregarding the problem you are working with, the ultimate criterion of a model's performance is how well the predicted values of a hydrological variable correspond to the measured ones.

During my nine years of work at CRES and ICAM as a Visiting Fellow, PhD student, Research Officer and Research Fellow, I participated in about a dozen different hydrological and multidisciplinary projects.

Which are my favourites? Firstly, I would like to mention the RIRDC project on the estimation of climate change impacts on the water availability for irrigation. This project gave me valuable regional experience in north-east Victorian catchments (the area covered the Upper Murray, Kiewa, Ovens and Goulburn Basins). Another important experience was working with climatologists from the CSIRO Division of Atmospheric Research.

Another memorable project was the MDBC funded work on the development of the operational streamflow forecasting algorithm using the sub-daily time step. We used a combined stochastically-deterministic approach where the steady state equation was inherited from the structure of the deterministic conceptual model IHACRES. The adjustment (assimilation) of the forecast values to measured flow was implemented using the Kalman filtering technique. I suppose my mathematical skills were mobilised to a maximum extent during the life of this project.

Over my last three years in ICAM/ANU I worked on the Integrated Water Resource Assessment and Management (IWRAM) Project. This project concerned sustainable water resource management in small rural communities in upland catchments in Thailand. I was working as a biophysical component researcher within IWRAM, which also included socio-economic and software engineering (DSS) components. I had a shocking experience meeting economists and social scientists working in the same research team with me. I couldn't even imagine how differently we had been thinking about the same problems. After a series of painful conflicts I learnt a very meaningful lesson - that stakeholders are much more interested in economics than in hydrology because most applicable hydrological results are delivered to stakeholders through economics. This is a very solid argument for integration.

I like fieldwork and am convinced that it is quite difficult to obtain valuable modelling results if your knowledge of a catchment is limited to GIS pictures and some data series down-loaded from the Internet. Once, when

analysing the hydrographs from the small catchment in Northern Thailand (Wat Chan in the Mae Chaem province, the Upper Ping River Basin), I found that the observations showed no response to rainfall over three months during the dry season of the monsoon cycle, despite the fact that some rainfall occurred over this period. I was ready to start writing a report on the high level of soil permeability in this area. Fortunately, we had an opportunity to travel to this catchment with our colleagues from the Department of Land Development of Thailand. When we reached the gauging site we found that the instrumental wall was empty. The station operator later told us that he always kept the gauge in the storeroom over the dry season.

My current work in the CRC, which I started in May 2001, is focused on sustainable water allocation in Australian catchments. I like my job and find it very challenging (see two previous *Catchword* papers on Project 3.1, where we tried to formulate our concept of modelling integration).

I am enthusiastically looking forward to future joint work with my CRC colleagues.

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WHERE ARE THEY NOW?

Report by Kevin Linton

Whoopee! It has taken quite a while. However, I have just about made the ceremony and have already found that I have a lot more spare time on my hands.

Organising one's time is very important when you are studying, particularly if you are studying part-time. Full-time work and part-time study mean competing workloads between your chosen area of research and your employer's time, and it seems the two are not always compatible.

I have been working within the rural water industry for eleven years and at Goulburn-Murray Water (G-MW) for seven. During that time I have upgraded my qualifications a couple of times and on both occasions my employers have been very supportive. For this I am grateful.

My water industry experience includes four years at Ballarat as a Diversions Inspector and six years in G-MW's Natural Resources Unit at Tatura, working in Salinity, Irrigation Drainage and Water Quality Programs.

My research into the 'Transportation and Cycling of Phosphorus in the Deakin Drain' was undertaken while I was working in the Drainage and Water Quality Programs. Essentially, I wanted to find out more about adsorption of phosphorus to irrigation drain sediments in northern Victoria. I succeeded in understanding the theory better. However, I was unable to fully describe what was occurring in the Deakin Drain.

For the last year, I have been working in the Irrigation Services unit at G-MW. Irrigation Services has an agricultural focus and I have spent time on benchmarking G-MW's performance as an irrigation provider for the Australian National Committee on Irrigation and Drainage (ANCID). The work included benchmarking G-MW's six gravity irrigation areas, undertaking a culture census and undertaking hydrogeology assessments of irrigation development. The move has allowed me to find out more about G-MW's business and enabled me to gain an appreciation of the strengths and weaknesses of this important industry in Northern Victoria.

I am a great believer in 'having a change' every four or five years. I suppose that is why I made the change from a natural resources focus to a more agricultural one. However, I feel phosphorus sorption in irrigation drains is 'unfinished business' and I may return to this topic if an opportunity should arise in the future.

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CRC TOOLKIT WEBSITE

The CRC for Catchment Hydrology is developing a new generation of catchment models and modelling support tools, integrated within a system of software known as the Catchment Modelling Toolkit. The purpose of the Toolkit is to improve the standard and efficiency of catchment modelling, and to provide much-needed enhancements in predictive capability for catchment managers.

Potential users are invited to learn more about the Catchment Modelling Toolkit by visiting www.catchment.crc.org.au/toolkit

From the Toolkit site you can subscribe to receive updates and other information as the Toolkit Project progresses.

For further information contact
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COOPERATIVE RESEARCH CENTRE FOR

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OUR MISSION

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

OUR RESEARCH

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

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

CRC AUSTRALIA

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

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Bureau of Meteorology
CSIRO Land and Water
Department of Land and Water Conservation, NSW
Department of Natural Resources and Environment, Vic
Goulburn-Murray Water
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