NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 105 MAY 2002

A NOTE FROM THE DIRECTOR

Professor Russell Mein

Inside...

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

COLLABORATIVE PLANNING - A KEY INVESTMENT FOR THE CRC

We have brought together some fourteen organisations to form the CRC for Catchment Hydrology. Each differs in corporate aims and cultures, but all need to see a return on their considerable investment in the Centre. Managing the CRC to meet these needs is an ongoing objective for the Board and Executive.

While interacting with a large and diverse group of Parties brings some costs, these are small when compared with the benefits and opportunities resulting from their participation. Each organisation has substantial resources of talented staff and support infrastructure; each is interested in improved management of water on catchments.

In the last few weeks, the CRC has been focusing on collaborative planning; we've been in operation for three years (of our current seven year term of funding), and looking ahead at what needs to be done to complete the mission. A key aim is to use the opportunity to maximise the effectiveness of the joint activity of the Parties in the Centre.

Ballarat Workshop
Our Annual Workshop was held this year in Ballarat, in mid-April. This three-day workshop is an important event for the CRC, bringing together its widely scattered participants. The structured format is designed to bring everyone up to date with the activities and expected outcomes of all of the Programs in the Centre. Program planning groups, and scenarios to promote integration, were given particular emphasis this year. Our group of postgraduate students impressed us all again with individual presentations of their work, and with more-than-able chairing of sessions. [With talent like theirs on the way, the future management of our natural resources will be in capable hands.]

The workshop is also a chance to bring in 'outsiders' to enrich the experience. Paul Willis, of the ABC's science group, gave a most entertaining and illuminating session on dealing with the media. A key message was that the mass media have a heavy bias towards entertainment of their respective audiences. Paul Sinclair, author of the recent 'The Murray - a river and its people', was another guest speaker; he presented a potted history of the Murray as seen by the people close to it, giving us a rather different perspective to those in management roles.

It was pleasing that several Board members were able to take time to join the workshop, and to paint a picture of the perspectives of their own organisations vis-a-vis the CRC. Our retiring Visitor, Jim Miller, commented favourably on their presence and interest, noting generally how effectively our Board contributes to Centre management.

Technical Advisory Groups [TAGs]
The two weeks following the Ballarat Workshop saw separate TAG meetings for each of our Program areas. Their tasks were to identify and formulate project ideas for our next round of core projects, due to start in 2003 when our first round are completed. These TAG meetings did not start with a 'blank sheet'; they were given priority areas of work emanating from a Future Issues Workshop held in May 2001, and a Board workshop convened last November. In addition, they were able to use a gap analysis (activities needed to complete the mission) developed by Focus Catchment Coordinators and Program Leaders, and statements of activities/capabilities of our user Parties on which we should build.

Each TAG comprised a mix of researchers and research users for a day-long meeting, and produced the ideas to go into the two-page abstracts to be considered by the Board on 31 May 2002. Each meeting was successful in producing collaborative research and implementation proposals which built on current knowledge.

Return on Investment
One of the participants at a TAG meeting mentioned that his organisation spent $300 000 just in planning its catchment modelling activities; he judged it money well spent. The principle applies even more so to a Centre dealing with fourteen participant organisations; the effort we spend in collaborative planning of our next round of projects will be more-than-rewarded by the 'return' we get from them. That is what the first 'C' - cooperative - in CRC's is all about.

Russell Mein
Tel: (03) 9905 4980
Email: russell.mein@eng.monash.edu.au

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fax 03 9905 5033
email
virginia.verrelli@eng.monash.edu.au

Centre Office Postal Address:
CRC for Catchment Hydrology
Department of Civil Engineering
PO Box 60 Monash University
Victoria 3800

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

Report by Fred Watson

Modelling stream water quality and stream health - Marmoset / LEMSS pilot study in South East Queensland

The CRC's work in the South East Queensland region continues with the development of a local-scale adjunct to the existing regional EMSS (Environmental Management Support System). A pilot study for Local EMSS (LEMSS) development is being conducted in Pine Rivers Shire, containing the watersheds of water supply reservoirs Lake Samsonvale and Lake Kurwongbah. The objectives are to be able to predict the impacts of land-use change on nutrient loads delivered to the reservoirs, and on stream health throughout the watersheds. The system differs from its regional sibling in using:

- a more finely scalable representation of landscape spatial heterogeneity and landscape connectivity as this relates to delivery of materials to receiving waters,
- a more-detailed representation of in-stream processes such as storage and transformation, and
- an effort to predict conceptual indicators of stream health that are aligned with the stream health monitoring program in the SEQ region.

As with the regional EMSS, the software is being developed within the Tarsier environmental modelling framework. About ten existing Tarsier modules are used to construct the system, with augmentations added as needed.

Landscape partitioning

A key component of the LEMSS is a novel method for partitioning large landscapes into the relatively homogeneous, connected units that are to be represented as the elementary units of the model. A specification of the system is that it should be able to represent spatial features as small as vegetative stream buffers. At the same time, it must be able to represent the effects of large-scale land-use change over 500 km^2 of landscape at the edge of urban areas. How might this be possible?

The partitioning algorithm begins at the watershed outlet and 'climbs' up the watershed following steepest-descent pathways in the reverse direction until it has 'visited' every 25 x 25m pixel in the landscape. Along the way, it creates the elementary spatial units of the modelling system as clusters of cells that all drain to the same point, and all have similar or identical landscape (e.g. land cover) properties (Fig. 1.1). A number of merging algorithms may then be applied to the resulting network, each resulting in a more efficient, but less-spatially explicit representation. In the extreme, the entire watershed can be represented as a one-dimensional series of flow-paths with all branching in the network replaced by a 'tally' variable indicating the number of stream branches represented by each link in the network.

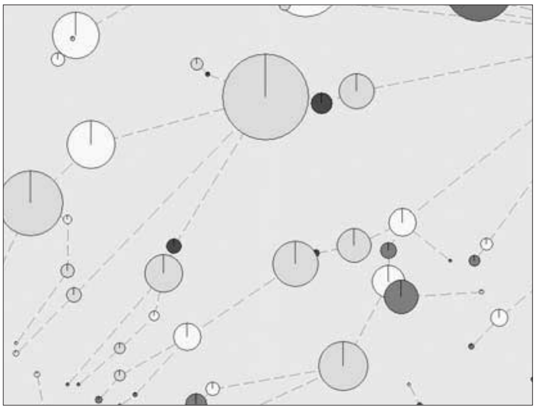

Fig. 1.1 Clusters of cells or units draining to same point

Marmoset stream model

The Marmoset stream model is one of the three models that are linked together to form the engine of the regional EMSS (the other two are the Colobus catchment model, and the Mandrill reservoir model). In the LEMSS, Marmoset's capabilities are being expanded somewhat. It retains its original capability to store and route water, sediment, and nutrients down stream networks. Hydraulic routing uses the Muskingum-Cunge method, with a novel link-by-link dynamic time-stepping feature to enforce numerical stability. Newly developed is the ability to represent detailed cross-sectional channel geometry for each link (Fig. 1.2), and dynamic calculation of kinematic wave celerity based on channel geometry and expected flow.

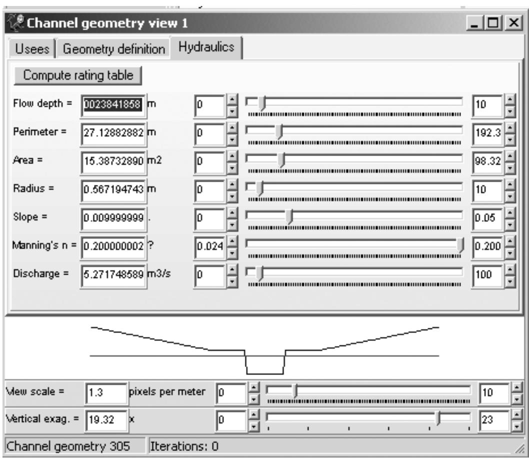

Fig. 1.2 Channel cross-section details

Sediment routing is performed using a transport-capacity scheme limited by sediment supply and storage, and flow velocity. At present, nutrient routing retains its original conservative, concentration-based routing but with the addition of a decay term. This is to be augmented with interactive terms involving sediment-sorption, and potentially, nutrient cycling based on primary production. A further new addition is a simple stream temperature model based on canopy-cover control of radiative flux, and advective flux through stream flow.

April 2002 workshop - stream health

A two-day workshop was held in Brisbane last month to present progress so far and to solicit input from stakeholders on what the model should represent, and how it should be used. An open session was attended by over 30 local and state agency staff. Two later sessions brought ten experts together to examine, in particular, what might be achieved with respect to numerical prediction of changes in stream health resulting from land use change. As one might expect, discussions were colorful and diverse, reflecting the differing approaches brought to the table.

Key issues were "How do we translate our stream ecosystem modelling knowledge from perennial to non-perennial streams?", and "Do we even need a spatial simulation model to predict something that ultimately may be best correlated with land-use alone?". A trial set of conceptual equations was assembled, and will be implemented within the model as a first step towards testing our ability to model the indicators of stream health that have been identified in a recent, extensive monitoring study in the region. The indicators draw on variables such as stream temperature, total nitrogen concentration, dissolved oxygen, and riparian canopy cover.

User interface

During the coming months, model development will transition into user interface development. Stakeholders have stated that an interface similar to that deployed in the regional EMSS would be preferable. Some novel features will also be incorporated, such as the use of clickable cadastral parcels to express land-use change. Parcel maps are the primary element that land managers in the shire use to manage land use. An interface will be explored that displays these and allows land-use trajectories to be expressed for each parcel.

The interface will also provide more-detailed ability for users to test the model against new data as they become available. The Pine Rivers region, although relatively well studied, remains data-sparse with respect to the processes represented within a detailed spatial modelling system such as the LEMSS. The primary goal of the system is the prediction of the impacts of land-use change on the quality of water supply and stream health. But equally, it has been developed as a tool for the structuring and testing of new knowledge and the identification of uncertainty and data gaps. Model validation and further development will be ongoing, as new land-use (Fig 1.3) and new data provide new understanding.

Fig. 1.3 Land-use, Pine Rivers Shire

Fred Watson[1], *for the LEMSS team, including:* Rob Vertessy, Tony McAlister, Mark O'Donohue, Dan Clowes, Shane Seaton , Joel Rahman, Bruce Harris.

Thanks also to experts: Ian Webster, Stuart Bunn, Peter Hairsine, Brad Sherman, Myriam Boormans, Heather Hunter, Eva Abal, Peter Rawlinson, Megan Lawler, Peter Loose.

[1]CSIRO Land and Water, and California State University Monterey Bay
Email: fred_watson@csumb.edu

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

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Jim Morris

Project 2.3 Predicting the effects of land-use changes on catchment water yield and stream salinity

Predicting forest water use with a stand growth model

The focus of Project 2.3 is on top-down catchment modelling, but one of its components is taking a smaller scale approach for predicting changes in forest transpiration with tree age and management under varying soil and climate conditions. While the top-down approach adopts a simple relationship between annual evapotranspiration by mature forests and annual rainfall, this cannot adequately describe the variation in water use by young plantations or regrowth forests as they grow to maturity.

3PG model

We have chosen to use 3PG (Figure 2.1) as a base for modelling young forests, for its appealing features of appropriate spatial and temporal scale, input requirements, and range of outputs. 3PG is a forest growth model with a monthly timestep, applicable to forest stands on a scale of hectares to hundreds of hectares. To model the influence of dynamic root zone water availability on growth, the model must estimate monthly stand transpiration and this makes it potentially useful for simple hydrological modelling where a reasonably detailed description of forest growth and management effects is required.

Validation required

However, because stand water use is incidental to the growth predictions for which 3PG was designed, this application of the model is relatively untested. Validation for key species is required before water use predictions can be confidently adopted for catchment planning. Each tree species is defined by a set of parameters (up to 48 of them, depending on the model version), some combinations of which might allow accurate growth predictions in spite of inaccurate water use estimates. Hence, parameter sets which have been validated only against growth data are not necessarily reliable for predicting transpiration, and we need to parameterise and/or validate the model against field measurements of water use and stand growth simultaneously.

Work in progress

This is the aim of work in progress at the Forest Science Centre (FSC) in the last 18 months. We have been measuring monthly stand water use, climate and soil moisture conditions in research plantations of major

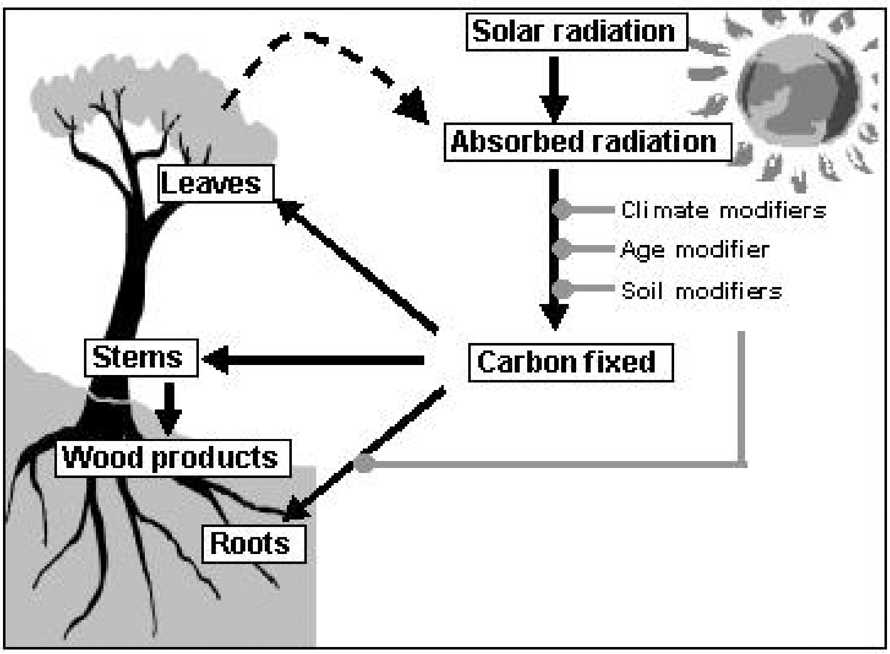

Figure 2.1 An outline of the 3PG forest growth model

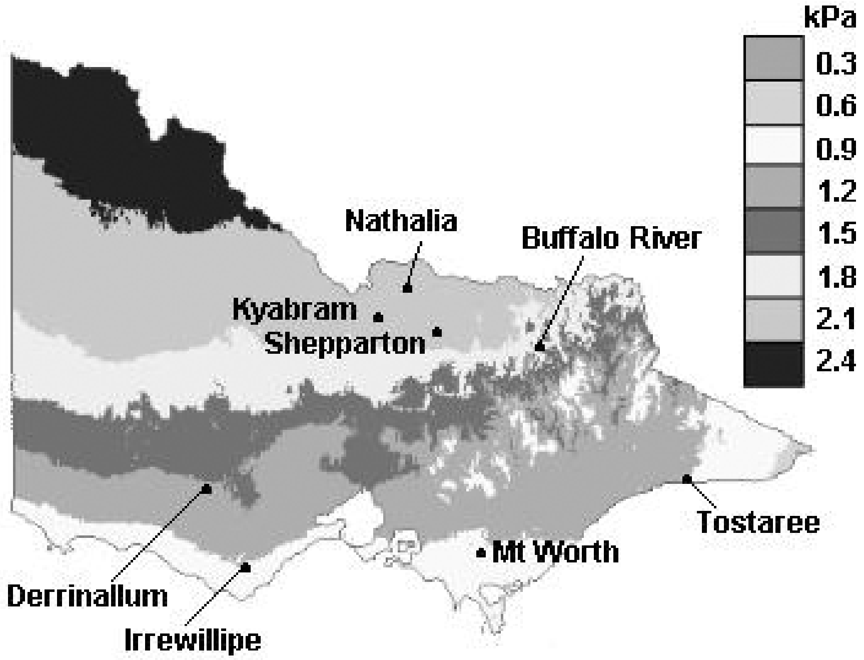

Figure 2.2 Mean vapour pressure deficit for Victoria in January, and water use monitoring sites for model parameterisation

eucalypt species across a range of climatic conditions (Figure 2.2). All the monitored stands have detailed records of growth from repeated measurements since planting, and hence are well suited for parameterising 3PG. We assume that for each species there is a unique and universal parameter set which defines its characteristics, and differences in growth at different locations are entirely due to climate, site and stand management factors. As data from more stands becomes available, the parameter estimates for a given species may be progressively refined.

Use of growth data

Our approach has been to parameterise 3PG against growth data only at first, and to compare the predicted monthly water use with observed values to seek evidence for any structural deficiencies or invalid assumptions within the model. Having established that these aspects are sound, we will parameterise it to fit water use and growth observations simultaneously over multiple sites, finally using an objective parameter estimation tool to optimise the parameter sets for the most important species.

The validated model will extend the capacity of the catchment-scale hydrological modelling developed within Project 2.3, to more accurately reflect the impacts of land use changes involving young forest establishment.

The development of 3PG in this project forms a link with concurrent FSC applications of the model including CRC associated Project 2.7 on eucalypt plantation impacts in southern China, and related modelling of trees in saline catchments.

Jim Morris
Tel: (03) 9450 8722
Email: jim.morris@nre.vic.gov.au

NEW TECHNICAL REPORT

OPTICAL PROPERTIES OF LEAVES IN THE VISIBLE AND NEAR-INFRARED UNDER BEAM AND DIFFUSE RADIANCE

by
Iain Hume
Tim McVicar
Michael Roderick

Report 02/3

Land-use impacts on the water balance and regional hydrology through vegetation. Agricultural and natural resource managers therefore need to know the amount of understorey and overstorey vegetation in these woodlands. Remote sensing has a role in this assessment.

This report describes laboratory studies to determine if the remote sensing signature of tree and grass leaves differ enough to allow them to be unmixed using broad-band satellite data. Additionally, further understanding of the way understorey and overstorey leaves absorb diffuse and beam light was developed. These results provide an avenue forward for remote sensing in this difficult area.

Copies are available through the Centre Office for $27.50

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

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

PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Teri Etchells

Project 3.1 integration of water balance, climatic and economic models

Supplying transferred entitlements

Water markets are one way of achieving sustainable water allocation in supply-constrained basins. To this end, the Council of Australian Governments' framework for water reform supported an expansion in the scale of trade stating "where cross-border trading is possible… trading arrangements be consistent and facilitate cross-border sales where this is socially, physically, and ecologically sustainable" (1994). Issues associated with the expansion of trade are being examined within Program 3, including third party effects and impacts on environmental flows.

Trading water entitlements requires that water be physically moved to supply the new location. This is a simple matter when entitlements are sold within a valley, but can become complex for intervalley trades. In the case of the Murray-Darling Basin, intervalley trading is possible (conceptually) over large areas, which raises some interesting questions. What are the limits to water markets? Can all entitlement-holders trade with each other? Could farmers in Queensland potentially trade entitlements with farmers in Victoria?

This article provides a discussion of how transferred entitlements can be supplied and the feasible limits to surface-water trade. Whilst this discussion may be obvious to some of our readers, the mechanics of water trading are complex and this background may be helpful in understanding future trade-related research.

How can entitlements be transferred?

There are three possible ways in which water can be transferred:

- direct transfer upstream or downstream along a reach
- substitution of upstream flows where a single storage supplies multiple reaches (upstream substitution)
- substitution of downstream flows where multiple reaches each contribute to the supply of a downstream reach (downstream substitution).

Figure 3.1 shows a simplified example of each mechanism. These examples assume there are no transmission losses in delivery, that each party receives their full entitlement (i.e. allocations are 100%) and that there are no other users in the system.

Separate constraints on the total volume of water that could be traded can be defined for each transfer mechanism, ie the magnitude of trade that can be physically and legally shifted. These constraints or limits are:

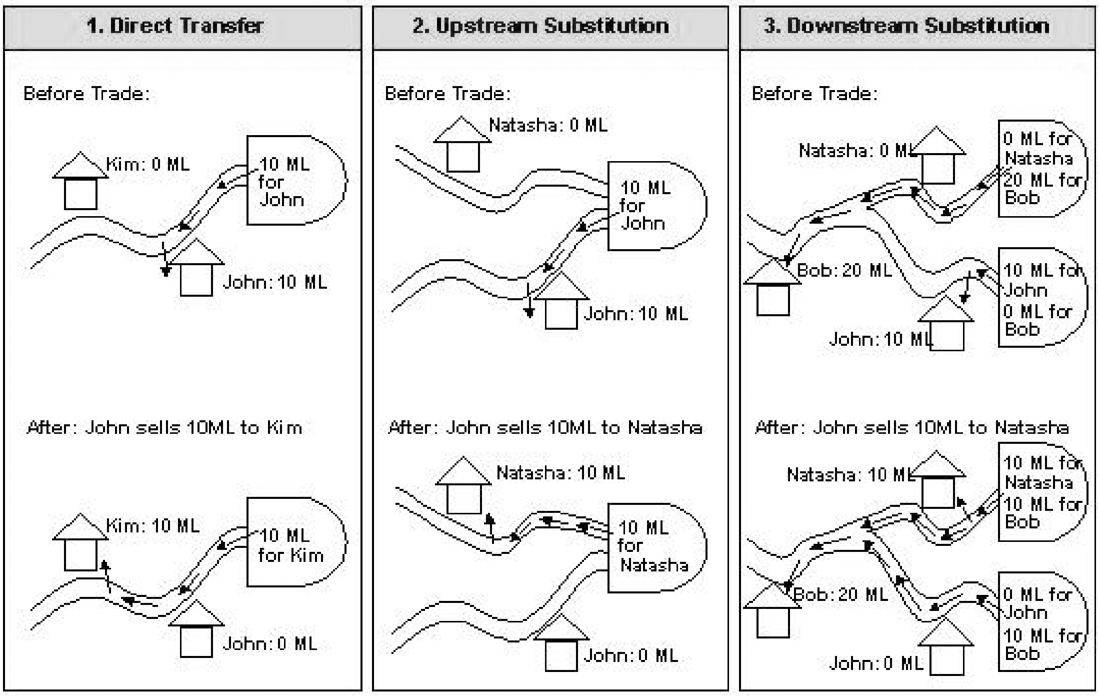

Fig. 3.1 Ways to transfer water entitlements

- Downstream direct transfer limit (the volume of entitlement in the selling valley)
- Upstream direct transfer limit (the lesser of the volume of entitlement in the selling valley and the volume supplied from the upstream buying valley)
- Downstream substitution limit (the lesser of entitlements in the selling valley and the flows supplied downstream into the connecting reach by the buying valley)
- Upstream substitution limit (the volume of supply for the selling valley from the connected storage)

How far can water be traded?

Through these mechanisms, it is conceivable that almost any two valleys in the Murray-Darling Basin could trade with each other. And, while it intuitively makes sense that neighbouring valleys should be able to trade, it is clearly inefficient to move water from Queensland to South Australia to facilitate a trade.

Two factors will limit the scale over which intervalley trading can occur:

- physical constraints and
- transmission losses.

Physical constraints include those limits outlined above as well as operational constraints (such as the Barmah Choke on the Murray River).

Transmission losses reduce the efficiency of transfers and hence reduce the efficiency of a trade.

If traders were forced to internalise these additional losses (e.g. through exchange rates), it is unlikely that large-scale trades would be more economically efficient than local trades.

So, although trade could conceivably occur over large distances, the feasibility and efficiency of transfers will restrain the scale of water markets.

Teri Etchells
Tel: (03) 9504 6232
Email: t.etchells@postgrad.unimelb.edu.au

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Looking back... looking forward

In the March 2002 edition of *Catchword* (No. 103), Tony Wong provided a thorough review of the activities which have been undertaken in the Urban Stormwater Quality Program, from 1999 to date. That summary was very timely, for two reasons. Firstly, Tony has stepped down as Program Leader (but will remain active within the Program's research activities), and secondly, the CRC has now entered the 'planning phase' for its second round of projects (2003-2006). As part of this planning process, the CRC Board, researchers and industry participants have been asking two questions:

1. What have we achieved?
2. What is still to be done?

What have we achieved?

In summarising the achievements of the Urban Stormwater Quality Program from 1999 to 2002, I would like to take the opportunity, on behalf of the entire team, to pay tribute to the leadership and commitment of Tony Wong. During the CRC's Annual Workshop in Ballarat, Tony's contribution was publicly acknowledged. A consistent message in these acknowledgements has been of Tony's clear vision for the products, and adoption of research, undertaken within the Urban Stormwater Quality Program.

The highlight of this vision has been the creation and delivery of MUSIC - the Model for Urban Stormwater Improvement Conceptualisation. This user-friendly software, which was launched in early May, has provided the stormwater and waterway management industries with a tool to evaluate alternative stormwater management strategies. Adoption of MUSIC has been extremely rapid, and industry feedback has been very positive.

This success has not been coincidental. The Urban Stormwater Quality Program's research was conceived around the need to deliver a product that met the industry's existing needs - to be able to predict the performance of stormwater management strategies in protecting and improving water quality. MUSIC has provided the focal point of all research conducted in the Urban Stormwater Quality Program, ensuring rapid adoption of the CRC's research findings. Much of the success of the Program has been due to Tony's unwaivering commitment to this focused research model.

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)
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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.

This report will be available from the Centre Office during mid-June 2002 for $33.00.

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

What is still to be done?

The CRC's planning process for its second round of projects is quite exhaustive, and involves a wide range of stakeholders. In January this year, a workshop was held to identify priority research gaps which will not be met by the outcomes from the CRC's first round of projects.

A number of gaps relevant to the Urban Stormwater Quality Program were identified:

1. *Ability to model inter-event processes in stormwater treatment facilities.*

   MUSIC predicts the behaviour of stormwater pollutants through a range of stormwater treatment facilities (e.g. wetlands, swales, bioretention systems). MUSIC's prediction of stormwater treatment performance, however, is based primarily on the processes which occurring during and as a result of storm 'events'. Further research is needed to understand and quantify the water quality changes (primarily chemical and biological processes) that occur in between these events.

2. *Ability to model the lifecycle costs of water sensitive urban design.*

   Whilst there has been some research commenced in this area (Sara Lloyd's PhD, for example), there is a need to encompass lifecycle cost analysis into MUSIC, so that both the treatment and economic performance (including construction, operation, maintenance and replacement costs) of alternative stormwater management strategies can be compared. This is important, given that the stormwater management industry, like any other, operates in an environment of economic constraints. Melbourne Water and Brisbane City Council have begun collecting cost data in order to contribute to research addressing this gap.

3. *Ability to define the socio-economic consequences of water sensitive urban design - to enable a "triple-bottom-line" (socal, economic and environmental) analysis to be undertaken.*

   Adoption of water sensitive urban design will depend not just on the expected water quality improvements, but also on reducing uncertainty about the social and economic consequences. Ultimately, the stormwater management industry requires tools which allow this "triple-bottom-line" comparison, as a basis for designing and evaluating stormwater management plans.

4. *Ability to link MUSIC to an integrated urban water cycle model.*

   Water sensitive design involves an integrated approach to managing the urban water cycle (including water use, re-use, treatment and disposal). Whilst the current version of MUSIC allows users to simulate water re-use from stormwater treatment facilities, the full intricacies of urban water cycle management are not within the scope of MUSIC. There is a need, therefore, to link MUSIC to existing urban water cycle models (e.g. the CRC's Aquacycle software). Addressing this issue could involve substantial collaboration with other researchers in this area, such as CSIRO's Urban Water Program.

5. *Linking MUSIC to whole-of-catchment models.*

   The mission of the CRC is: "To deliver to resource managers the capability to assess the hydrologic impact of land-use and water-management decisions at whole-of-catchment scale". To achieve this mission, the CRC needs to offer users the ability to integrate outputs from models at a variety of scales. A good example of this integration would be allowing managers to use the output from MUSIC (for example, the expected water quality from a proposed stormwater management plan) as a direct input to a local or whole-of-catchment EMSS (Environmental Management Support System - see *Catchword* No. 95, June 2001). Creating this ability contributes to the CRC's goal of creating a Toolkit. The Toolkit will allow managers to select the appropriate 'modules' for their requirement. Ultimately, MUSIC will link with a range of catchment models.

6. *Improved understanding of the characteristics of urban stormwater.*

   Effective design of stormwater treatment measures relies on being able to predict the amount and type of pollutants generated in a catchment. Despite some significant advances in the last three years, there are still significant knowledge gaps in this area:

   - the degree of correlation between urban stormwater pollutants
   - the degree of serial correlation in pollutant concentration (ie. correlation over time)
   - the particle size distribution of urban stormwater pollutants, and the association of specific contaminants (e.g. metals, hydrocarbons, nutrient species) to various particle sizes.

Research into these areas will allow urban stormwater managers to better estimate the likely pollutant load generation from given catchments, and to better target their management strategies to remove the pollutants that are of concern.

Developing the Future Projects
Following the identification of key research gaps, the next step in the project planning process was a meeting of the Technical Advisory Group (TAG) for the Urban Stormwater Quality Program (there is a separate TAG for each CRC Program). The TAG represents a range of stakeholders, including researchers in other CRC programs, researchers in related organisations (CSIRO Urban Water Program, CRC for Freshwater Ecology), and industry participants with an interest in urban stormwater-related issues.

The outcome of the TAG meeting was a focused set of priority projects, which aim to address the identified gaps, in an integrated manner. Projects developed by the TAG all involved substantial collaboration, both within and external to the CRC, and aim to contribute to the CRC's mission of allowing land and water use consequences to be predicted at whole-of-catchment scale.

Between now and the end of the year, projects arising from the TAG's deliberations will be presented to the Board, who will have the unenviable task of juggling priorities and available resources. Project Agreements (due for completion by November 2002) will involve further stakeholder input, to refine their focus and methodology.

From a personal perspective, the planning process so far has been very rewarding. Firstly, it has allowed us to consider our achievements (something which is often forgotten). Secondly, it has reassured me of the shared vision of research needs in the urban stormwater management industry. This shared vision - between the researchers and industry practitioners - is what will ensure CRC research is adopted and implemented. This, after all, is our ultimate goal. Our team looks forward to pursuing this goal.

Tim Fletcher
Tel: (03) 9905 2599
Email: tim.fletcher@eng.monash.edu.au

CLARIFICATION

The April edition (No. 104) of *Catchword* included an article entitled "Stormwater treatment devices - How effective are they? A case study, Golden Pond, Brisbane". The article presented results of a study undertaken to determine both dry and wet weather water quality in an urban catchment, and summarised changes in water quality through a number of stormwater quality improvement devices (SQIDs) in the catchment. Conclusions of the article referred to changes in soluble pollutant concentrations discharging from gross pollutant traps (GPTs) in the catchment. The article referred to these GPTs as a potential "source of soluble nutrients". It appears that some confusion may arise from these findings, and the CRC wishes to clarify their context:

Gross pollutant traps are primarily designed for the removal of litter (both anthropogenic and organic, such as exotic leaf litter) and coarse sediment. In achieving this, GPTs may trap a significant amount of nutrients, primarily in the particulate form. During inter-event periods (ie. in the dry period between storms), some of this trapped nutrient may undergo biochemical transformation, potentially resulting in a release of some of the trapped nutrients in the soluble form (e.g. soluble P). These findings do not suggest that the GPT is an additional source of overall nutrient load (in some cases the inter-event period processes could also result in an overall reduction in nitrogen, due to denitrification), or that it is ineffective: the primary purpose of a GPT is the efficient removal of litter and coarse sediment.

An appropriate stormwater 'treatment train' will therefore contain a number of treatment measures, each targeting the specific range of stormwater pollutants for which they are designed.

The relative importance of particular nutrient species (ie. soluble vs. particulate forms) will depend on the circumstances in a particular receiving waterbody. In some cases, it may be the overall nutrient load reduction that is considered important.

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
Mike Stewardson
Lance Lloyd
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.

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.

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Sri Srikanthan and Lionel Siriwardena

Project: 5.2 National data bank of stochastic climate and streamflow models

Daily rainfall data - a widespread requirement

Long sequences of daily rainfall are increasingly required, not only for hydrological purposes, but also to provide inputs for models of crop growth, landfills, tailing dams, land disposal of liquid wastes and other environmentally sensitive projects.

Evaluation of alternative data generation models

Evaluation of a number of daily rainfall data generation models, using daily rainfall data from 21 stations located in various parts of Australia, resulted in two models with satisfactory performance with regard to most of the statistical characteristics. These models are the Transition Probability Matrix model with Boughton's correction (TPMb) and the simplified Wang-Nathan (WNs) model. The only differences between the two models were that TPMb preserved the daily rainfall on different types of wet days (solitary wet days or consecutive wet days) while the WNs model preserved the correlations between the monthly rainfall better than the TPMb model.

Generation of streamflows

As the stochastically generated rainfall data is used as an input to other models, it was decided to assess the performance of the two models with regard to their ability to generate streamflows. A simple rainfall-runoff model (SIMHYD) was used to generate streamflows from the generated rainfall data for eight catchments selected from various parts of Australia with areas varying from about 50 to 700 km^2 (Figure 5.1).

Comparison of results

One hundred replicates of daily rainfall data were generated by using the two daily rainfall data generation models. As before, several statistical characteristics were computed to evaluate the model performance. Both models satisfactorily preserved most of the statistics for the eight sites selected. The only notable differences were the mean daily rainfall on different types of wet days (Figure 5.2) and the monthly serial correlation (Figure 5.3).

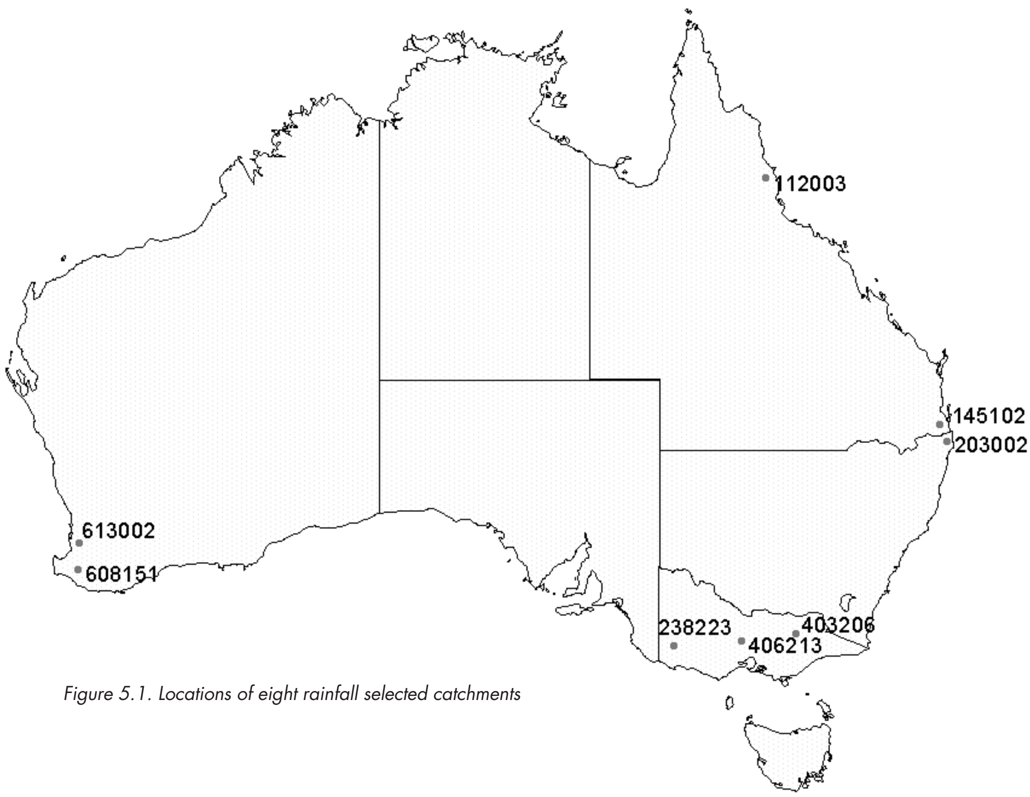


Figure 5.1. Locations of eight rainfall selected catchments

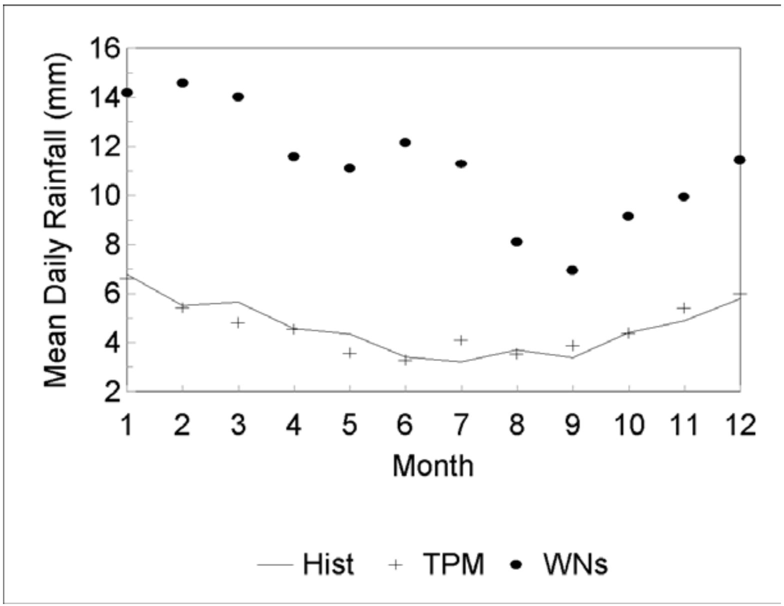


Figure 5.2. Mean daily rainfall on solitary wet days for Coopers Creek catchment

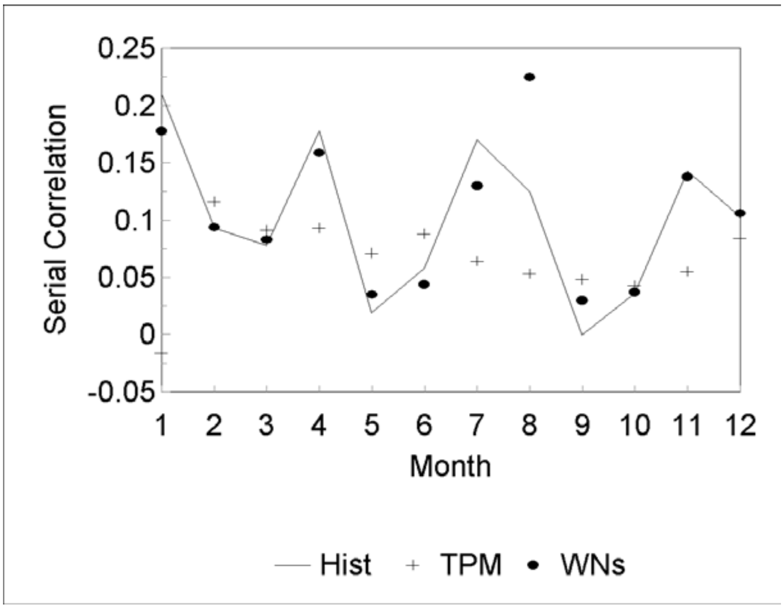


Figure 5.3. The serial correlation for monthly rainfall for Coopers Creek catchment

Streamflow comparisons

The generated rainfall data were then run through the rainfall-runoff model to produce the streamflow. From the generated streamflow data, a number of statistical characteristics at daily, monthly and annual time intervals were calculated to evaluate the models.

Visual inspection of the results shows that there is very little difference between the streamflows generated from the two rainfall input. Also, the streamflows resulting from 3-day rainfall events were examined to see whether the rainfall amounts within wet spells makes any difference to the streamflow.

Here again, the difference is small with TPMb model being more consistent in preserving various characteristics of the event streamflows.

Conclusions

It can be concluded from this study that both the models can be used to generate daily rainfall data for most practical applications. A technical report detailing the above work is being prepared.

Sri Srikanthan
Tel: (03) 9669 4513
Email: sri@bom.gov.au

Lionel Siriwardena
Tel: (03) 8344 0226
Email: lsiri@unimelb.edu.au

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

PREFER YOUR *CATCHWORD* BY EMAIL?

Almost one third of *Catchword* readers receive their copy by email. Each month the Centre sends out a pdf copy of *Catchword* to email subscribers as well as a link to the CRC website from which *Catchword* can be downloaded.

If you would like to reduce the paper on your desk please contact the Centre Office on 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au

Over 1200 people receive *Catchword* each month.

PROGRAM 6

RIVER RESTORATION

Program Leader
IAN RUTHERFURD

Report by Nick Marsh

Project 6.4:- Evaluation of Riparian Revegetation in a South East Queensland Catchment

Vegetation and water temperature - Echidna Creek

Project 6.4: "Evaluation of Riparian Revegetation in a South East Queensland Catchment" shows that the removal of riparian vegetation from a sub-tropical stream can increase the maximum water temperature by up to 13°C.

Echidna Creek is a small perennial stream (1-2m wide), near Nambour in SE Qld. The stream had patchy riparian vegetation and was accessed by cattle for drinking/bathing. Echidna Creek was fenced and replanted with native riparian vegetation in December 2000 - March 2001. We are monitoring several elements of Echidna Creek in conjunction with several nearby streams to see if the recovery of Echidna Creek follows our theorised responses. One of the elements we are monitoring is the change in water temperature due to revegetation.

Biological effects

One would expect that as the removal of vegetation from a stream affects the water temperature, it may also have a detrimental biological effect. Unfortunately the species-specific effect of changes in water temperature are poorly known for native fish and macroinvertebrates. However elevated temperatures can have a lethal effect on fish arising from fluid electrolyte imbalance. In addition, elevated temperatures can effect the tolerance of fish to other stresses such as low dissolved oxygen.

Clearing and temperature

On Echidna creek we are evaluating the ability to alter the in-stream temperature by altering the riparian vegetation. The evaluation project is specifically designed to quantify the rate of improvement (naturalising) of water temperature in response to revegetation in a subtropical stream. As first step, it is valuable to quantify the difference in water temperature between vegetated and cleared streams. If the difference in water temperature is small then the role of riparian vegetation in controlling stream temperature may be limited.

Temperature recording

We are recording the water temperature every 1/2 hour in Echidna Creek as well as at two cleared streams (negative control) and one vegetated stream (positive control). Comparisons of cleared and vegetated streams (Figure 6.1) show that for small streams in SE Qld we can have up to a 13°C increase in daily maximum water temperature in response to vegetation clearing. The range of daily temperatures can also increased (to about 12°C); resulting in an increased daily fluctuation from around 0.2-0.5°C in the vegetated stream to 10-12°C in the cleared sections of Echidna Creek. This rapid rate of temperature change may be just as significant to biota as the maximum daily temperature peaks.

Recovery period for streams

So far we have two summers worth of temperature data for Echidna Creek. The stream has been replanted with native riparian vegetation (May 2001) and is growing rapidly (nearing canopy closure in upper reaches). We expect to detect a change in water temperature due to shading over the 2002-2003 summer. The results of the water temperature evaluation indicate that for sub-tropical streams the potential recovery time for water temperature is of the order of a few years.

Sediment and turbidity aspects

In addition to the temperature evaluation, we are continuously monitoring turbidity as an indirect measure of suspended solids. We have learned a lot about continuous monitoring, and have an almost continuous record of suspended sediment for the past 15 months. We expect the response in the sediment load due to revegetation over the coming summer. Both the temperature and turbidity monitoring will continue as the riparian vegetation achieves canopy closer.

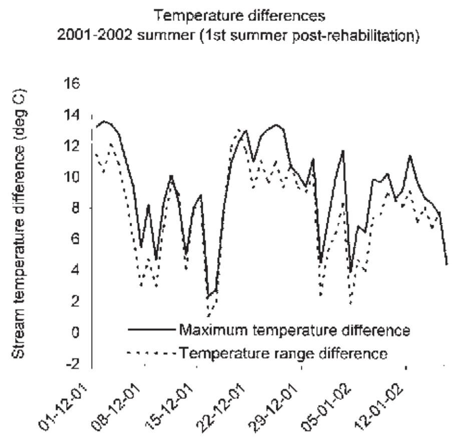


Figure 6.1: Comparison of daily maximum temperatures and daily temperature range for Echidna Creek and a nearby fully vegetated stream.

Nick Marsh
Tel: (07) 3875 7101
Email: nick.marsh@mailbox.gu.edu.au

PROGRAM 7

COMMUNICATION AND ADOPTION

Program Leader
DAVID PERRY

music
Model for Urban Stormwater Improvement Conceptualisation

The Flow on Effect - May 2002

MUSIC - software to help users evaluate stormwater management systems to meet water quality objectives

Introduction

Many organisations, from governments to catchment management groups, have introduced initiatives to protect the aquatic environment of urban areas. Often these initiatives have focused on 'point sources' of pollution, such as sewage discharge and industrial effluent. Building on the success of these initiatives, organisations are now turning their attention to 'diffuse sources' of pollution, particularly urban stormwater - a major carrier of urban pollutants.

It is difficult to prevent stormwater from polluting creeks because runoff can be contaminated almost anywhere rain falls. Consequently, successful initiatives to manage stormwater adopt a *catchment-wide* approach. The diffuse sources of stormwater pollution also demand a multi-disciplinary approach.

Successful initiatives may need to integrate a range of urban planning and design disciplines, including urban hydrology, land-use planning, landscape design and asset life-cycle economics. However, urban stormwater managers do not have answers to key questions such as:

- What is the likely water quality from catchments of different levels of urbanisation?
- What is the performance of individual stormwater treatment measures?
- What about the performance of treatment measures when combined in parallel or series?
- How can I compare the performance, benefits and costs of alternative stormwater treatment strategies?

Figure 7.1 Aspects of water sensitive urban design. From top: vegetated channel incorporated into urban streetscape; bioretention system at Lynbrook Estate, Melbourne; constructed wetland for water quality improvement; healthy urban waterway.

NEW SOFTWARE

MODEL FOR URBAN STORMWATER IMPROVEMENT CONCEPTUALISATION (MUSIC)

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

MUSIC will be available from the Centre Office in mid-June 2002 for $88.00

Individuals will need to sign a Licence Agreement (available from the Centre Office)

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

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

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.

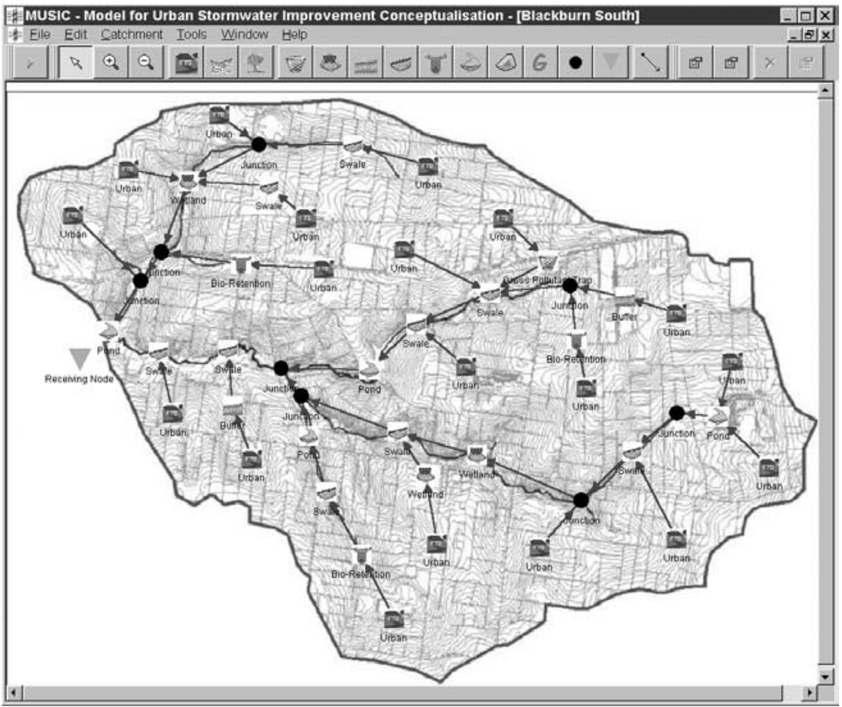
Copies are available through the Centre Office for $22.00.

The development of MUSIC

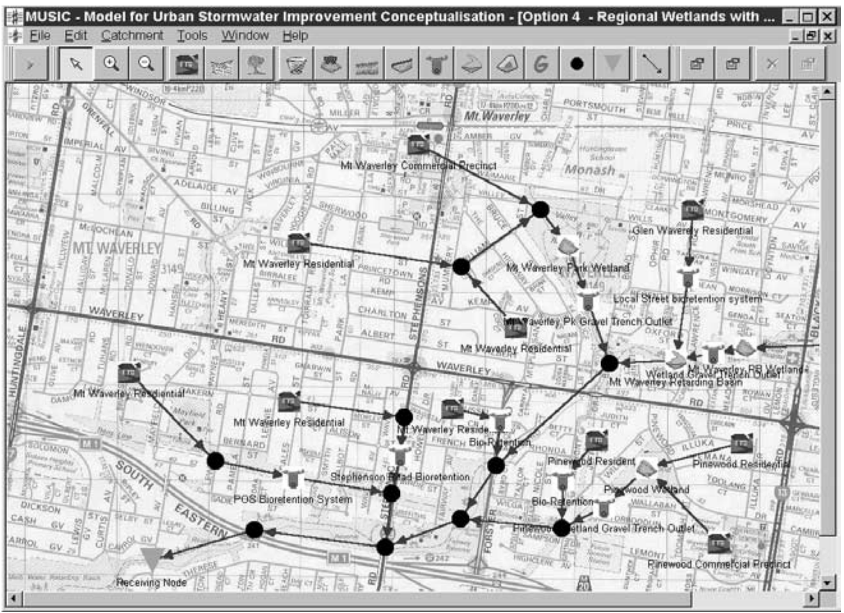
The Cooperative Research Centre (CRC) for Catchment Hydrology is addressing these deficiencies through its Urban Stormwater Quality Research Program. Our research has culminated in MUSIC (Model for Urban Stormwater Improvement Conceptualisation).

As an aid to decision-making, MUSIC assesses the performance of stormwater quality management systems. It is intended to help organisations plan and design - at a conceptual level - appropriate urban stormwater management systems for their catchments.

A pilot version of the MUSIC software was released in March 2001 for preliminary testing by Melbourne Water, Brisbane City Council and associated consultants. After eight months of trial and further development, MUSIC is now available to the wider stormwater industry. The model's algorithms are based on the known performance characteristics of common stormwater quality improvement measures. Based on research undertaken by the CRC for Catchment Hydrology and other organisations, MUSIC's data represents the most reliable information currently available in our industry.



(a)



(b)

Figure 7.2 MUSIC can represent stormwater management systems at regional (a) or precinct (b) scales.

Capability

MUSIC simulates the operation of the following different types of stormwater quality improvement facilities:


Buffer

Buffer Strips (commonly used as a source control measure, particularly for management of road runoff, and are effective in the removal of coarse to medium-size sediments)


Swale

Vegetated Swales (open channel systems that utilise vegetation to aid the removal of sediment and suspended solids. Their removal efficiency is dependent on the density and height of the vegetation in the channel)


Wetlands

Wetlands (an effective stormwater treatment measure for the removal of fine suspended solids and associated contaminants, as well as soluble contaminants. MUSIC can also model the reuse of treated stormwater stored in wetland systems)


Bio-Retention

Bio-retention Systems (promote the removal of particulate and soluble contaminants by passing stormwater water through a filter medium. The type of filter medium determines the effectiveness of the pollutant removal)


Pond

Ponds (use the temporary detention of stormwater to facilitate settling of suspended solids and include open water bodies without significant shallow vegetated areas in the predominant flow paths) and ornamental ponds. (MUSIC can also model the reuse of treated stormwater stored in ponds)


Sedimentation Basins

Sedimentation Basins (open water bodies primarily for removing coarse and medium particles. This is achieved almost entirely by the temporary detention of stormwater to facilitate settling of suspended solids)


Gross Pollutant Traps

Gross Pollutant Traps (devices for effective removal of solids typically larger than 5mm).


General Treatment Nodes

Generic Treatment Nodes (enable the user to provide for flows and water quality for stormwater quality treatment measures that are not explicitly modelled in MUSIC. Generic nodes can also be used to model such situations as flow diversion, flow dilution and contamination by sewer overflow)

Figure 7.3 Constructed wetland for stormwater treatment at the regional scale (Melbourne).

Figure 7.4 Bioretention system for stormwater treatment at the precinct scale (Brisbane)

Application

MUSIC is a decision-support-system. This 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.

The model supports a risk-based approach to assessing:

(i) the long-term frequency of aquatic ecosystem exposure to pollutant concentrations above a pre-specified threshold level

(ii) the long-term mean annual pollutant load delivered to receiving waters.

MUSIC is designed to simulate stormwater systems in urban catchments operating at a range of time and space scales; catchment areas from 0.01 km^2 to 100 km^2 and modelling time steps ranging from 6 minutes to 24 hours. The CRC for Catchment Hydrology plans support and training for the use of MUSIC. The CRC plans to update the software annually as results from the CRC's and other organisations' research become available and are incorporated into the model.

MUSIC TRAINING COURSES

Brisbane 8-9 July 2002
Sydney 11-12 July 2002
Melbourne 15-16 July 2002
Adelaide 18-19 July 2002

The two-day course involves lectures, hands-on worked examples and case studies to familiarise participants with the scientific underpinning of **MUSIC** and its operation in developing stormwater management strategies for water quality objectives. Course presenters include members of the **MUSIC** development team and Associate Professor Tony Wong.

Cost and Registration

Registration for a **MUSIC** training course costs $880 (incl. 10% GST) per participant and includes a printed colour copy of the **MUSIC** User Manual (used extensively in the training course), lunch and morning and afternoon tea.

Each course is limited to 20 participants at each location and places will be allocated in order of receipt of registration forms.

To register for the workshop, please contact Virginia Verrelli at the CRC for Catchment Hydrology Centre Office on 03 9905 5033 or email crcch@eng.monash.edu.au

Registration forms must be received at the Centre Office by close of business on 28 June 2002.

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

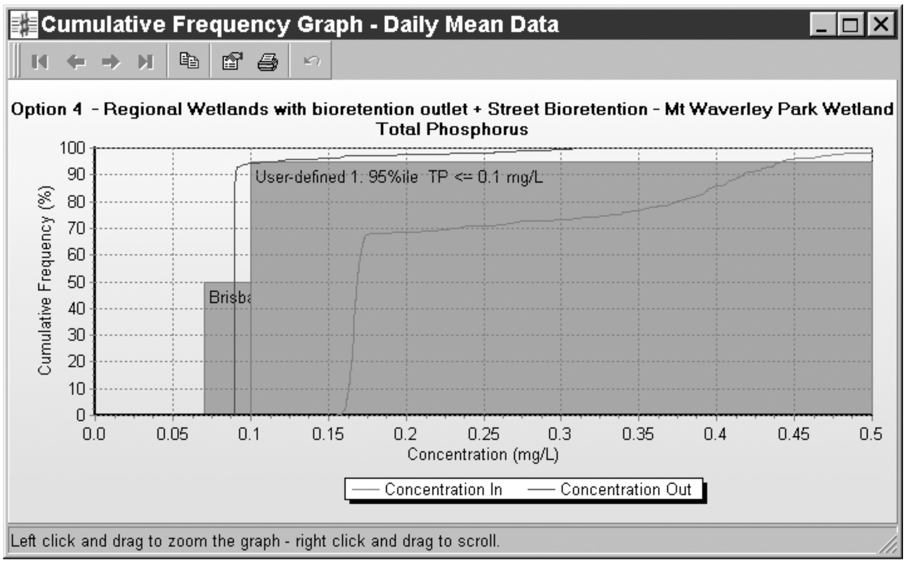
OR

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



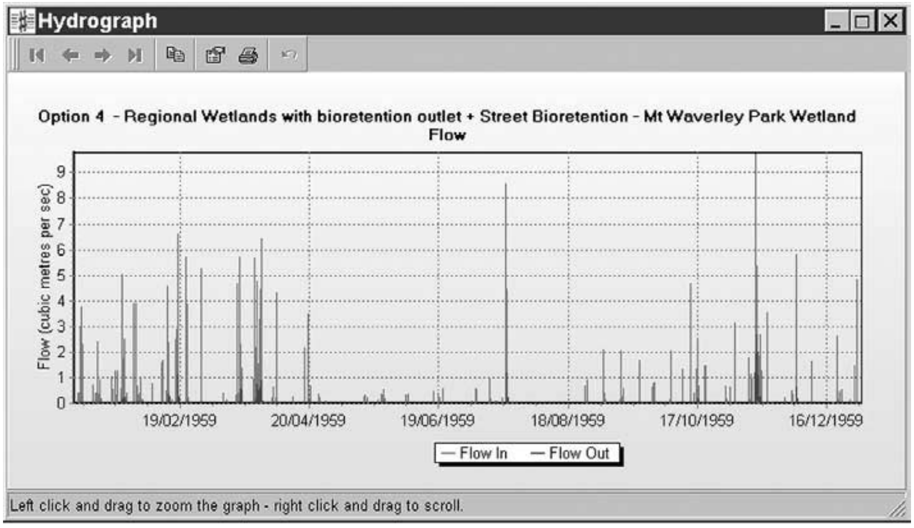


Figure 7.5 MUSIC output allows for easy appraisal of alternative stormwater management strategies

Music development team

Team members are:

- Assoc. Prof. Tony Wong (Team Leader, Monash University)
- John Coleman (CSIRO Land and Water)
- Hugh Duncan (Melbourne Water/Monash University)
- Dr. Tim Fletcher (Monash University)
- Dr. Graham Jenkins (Griffith University)
- Lionel Siriwardena (The University of Melbourne)
- Rick Wootton (Monash University)

Further information

For further information about MUSIC, its application or to order a copy of the MUSIC software please contact:

CRC for Catchment Hydrology Centre Office
Department of Civil Engineering
PO Box 60 Monash University, VIC 3800
Tel: 03 9905 2704
Fax: 03 9905 5033
Email: crcch@eng.monash.edu.au
www.catchment.crc.org.au

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

POSTGRADUATES AND THEIR PROJECTS

Alice Best

I graduated from Melbourne University in 1997 with a Bachelor of Engineering (Environmental) and Bachelor of Science. After spending a year working and travelling around Europe I headed back to Australia in mid-1999 and started working for SMEC Australia as a water resources engineer in their Sydney office. After working on a number of interesting and varied projects at SMEC, I decided I was interested in pursuing further study.

During my undergraduate days at Melbourne University I had had contact with the CRC for Catchment Hydrology, not only through my studies, but also while working at Goulburn-Murray Water as a student engineer. I had then had further contact with the CRC through a secondment to DLWC. After that I decided that I would apply for a PhD scholarship in mid 2000. I was lucky enough to be offered a project within Project 2.3: "Predicting the effects of landuse changes on water yield and stream salinity", and started my PhD in February 2001.

My PhD project is titled 'Prediction of the effect of vegetation change on water yield using paired catchment data' and is supervised by Lu Zhang, Tom McMahon and Andrew Western. The motivation for this project comes from Forest Plantations 2020 vision to treble the area of tree plantation within Australia by the year 2020. The implementation of this plan is likely to have an impact on water yield at both the local and regional scale. Therefore, to develop sustainable management options, it is necessary to predict on the impact of vegetation change on water yield and its seasonal variability.

The aim of my project is to predict the changes in water yield as a result of permanent vegetation changes on seasonal water yield. While the project will have an Australian focus, it is proposed that global paired catchment data will allow an assessment of the impact of vegetation changes in different climatic zones on different continents. It is anticipated that this project will be completed by April 2004.

Alice Best
Tel: (02) 6246 5730
Email: alice.best@csiro.au

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.

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

CRC Centre Office
tel 03 9905 2704
fax 03 9905 5033
email
virginia.verrelli@eng.monash.edu.au

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

CRC PROFILE

Our CRC Profile for May is:

James Whelan

It is often a surprise how one's interests and experiences can lead in quite unexpected directions. Sometimes this involves coming full circle. As a high school student I was once offered a public service cadetship in hydrology. Almost twenty years later, I was appointed by the CRC in August 2000, joining Professor John Fien to support the education and training program. This position provides interesting and challenging opportunities to pursue my two key interests: environment and education.

During the intervening years I completed three (soon to be four) degrees and developed a passion for community and adult education. I first worked as a secondary teacher (English and Geography) in East Gippsland. The life of a teacher wasn't for me, so I took on a position in Central Queensland as coordinator of a community education program. This position was a real buzz and involved extensive travel (we covered more than a million square kilometres). Next, I had a three-year stint in Newcastle with the Wilderness Society. While in this position, I completed a Masters Degree in education, focusing on community-based environmental education. As an environmental advocate, I have worked on conservation issues associated with wetlands, tropical and old-growth native forests, sustainable urban transport and air quality.

Finally, I arrived in Brisbane where I commenced a PhD with Griffith University. This study explores the intersection between education and environmental advocacy to propose suitable education and training approaches for adoption within the environment movement. During my part-time candidature, I have worked for the Queensland Conservation Council as a community educator and lectured in the Masters Degree in Environmental Education here at Griffith University.

The CRC's Program 8 comprises both a service function (the education and training work which is my priority) and a social science research project. My position provides opportunities to work closely with the small group of researchers based here at Griffith who are exploring social issues including volunteerism, partnerships, and community sector involvement in both research and environmental decision-making. My experience in the community sector tells me there is often a very significant social dimension to the adoption of sustainable catchment management principles and practices. Science is often one of several factors influencing policy and infrastructure decisions. This issue, among others, is explored during the regular meetings of the citizen science research group which bring together postgraduates and other social science researchers from our CRC and the Coastal CRC.

I enjoy my work with Program 8. In particular, I find it very rewarding to support our group of postgraduate researchers. Through our electronic discussion group, CRC postgrads share information about their professional development and alert each other to conferences, workshops, seminars and so on. Research institutions like ours seem almost 'virtual' as we are located at several sites and communicate mostly by email, so it's important to put faces to names at the CRC's Annual Workshop. This year's was no exception. The postgrads did a great job chairing most sessions and providing entertainment. They were also responsible for some of the best presentations.

Researchers and stakeholders interested in education and training activities can contact me anytime. As convenor of the CRC Education Committee, I would be glad to consider how we can support your efforts.

James Whelan
Tel: (07) 3875 7457
Email: james.whelan@mailbox.gu.edu.au

WHERE ARE THEY NOW?

Report by Mark Bailey

A long time ago in a galaxy far, far away…

So begins each episode of the Star Wars film series (my favourite). Somehow, it seems as apt description of my involvement with the CRC for Catchment Hydrology. I was seconded from the (then) Rural Water Corporation to the CRC as a Master of Engineering Science student at Monash University in 1994. My secondment and enrolment occurred as an in-kind contribution, and was completed 3.5 years later. During this time, my studies were upgraded to PhD status and I investigated techniques of analysing the uncertainty in catchment hydrological models.

After several years of persistence, effort, worry and work, I finally did submit my PhD thesis. The examiners have not yet presented their reports, so I cannot claim ultimate finalisation of my studies. However, the submission of my thesis represented a significant achievement for me personally. I am proud of my work, and deeply grateful to the continual support I received from my supervisors Luke Connell, Rory Nathan and Russell Mein. I would never have finished without their encouragement and assistance; it is a debt I doubt I will ever be able to fully repay.

At the conclusion of my secondment, I moved to Tatura to work with GoulburnMurray Water (GMW), an independent authority formed from the Rural Water Corporation. Almost five years later, I am still with GMW and thoroughly enjoying the challenges it provides. After a brief stint with the Production Management Unit, I worked on water quality management with the Natural Resources Unit for three years. My past involvement with the CRC proved invaluable in this job, because I was able to draw on information provided by the different research programs to maintain and enhance water quality. It really proved to me how much knowledge the CRC provided, and how useful it really was!

I am now back with the Production Management Unit, and working on a multitude of roles associated with the operation of the GMW distribution systems. The tasks include:

- System operation management, which includes assessing storage release requirements and supply demands throughout the GMW region
- Preparation of the annual Water Audit monitoring report for Victoria, as required under the Murray-Darling Basin cap on diversions
- Contributions to projects conducted under the Victorian State Government's water savings program

The Production Management Unit also has an important flood management role, but this has not been required since I joined GMW almost five years ago. This prolonged sequence of dry weather has really tested GMW and irrigation customers, and unfortunately appears set to continue.

I think I have found a home in Tatura. It's great little town and provides everything I want or need, especially now that I have more personal time available. And while there were some regrets with my studies, my time with the CRC was an invaluable and really rewarding experience. Good luck to everyone at the CRC, and thanks for everything!

NEWS FLASH!!! In late breaking news received 8 May 2002, the two examiners have passed my thesis subject to minor amendments! My journey is almost complete, and the relief is overwhelming. The exhilaration is only just beginning…

Mark Bailey
Tel: (03) 5833 5489
Email: markab@g-mwater.com.au

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.

COOPERATIVE RESEARCH CENTRE FOR

CATCHMENT HYDROLOGY

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

crcch@eng.monash.edu.au

CRC AUSTRALIA

If undelivered return to:

Department of Civil Engineering
PO Box 60
Monash University
Vic 3800

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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:

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