NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 116 MAY 2003

A NOTE FROM THE DIRECTOR

Professor Rob Vertessy

Inside...

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

EXTENDING OUR INFLUENCE

Industry uptake and our Toolkit

The Commonwealth CRC Program was set up to promote the development of new knowledge and technology and to encourage its uptake by industry. Industry uptake or adoption is front and centre in the Commonwealth's performance measures for CRCs. Industry Parties that invest in CRCs expect that they will gain access to useful knowledge and products that would otherwise be unavailable or difficult to harness without a CRC devoted to their needs. For these reasons, our own CRC's first priority is to develop useful knowledge and technology and to promote its uptake by the land and water management industry. In this regard, we have focused our energies on the development and delivery of the Catchment Modelling Toolkit, a set of software that will provide a quantitative basis for Integrated Catchment Management. All of our research Program groups are building specific modelling software to go into this Toolkit. Most importantly, representatives from all of our industry Parties are involved in the design and evaluation of that software, as well as in its promotion to colleagues and peers.

Our CRC is fortunate to include most of the large land and water management agencies in the east of Australia. This gives us a solid user group; our priority is to build and deliver the Catchment Modelling Toolkit to them and assist them in applying it. However, our potential audience is much larger and everyone in our CRC can see the wisdom of promoting adoption of the Toolkit beyond our parties. Hence, we are employing a range of strategies to engage with this broader set of end-users.

Toolkit delivery and the Catchment Modelling School

Our prime delivery pathway for the Toolkit is a dedicated web site. All of the Toolkit products will eventually be downloadable at this site, at low or no cost. Each of these products will be supported by various forms of documentation, news announcements and a user forum e-group via which end-users can share experiences in the application of the software. David Perry's article under Program 7 (Communication and Adoption) will provide readers with more detail about our plans for delivery. As most of these products are being released to the industry for the first time, we anticipate significant evolution in them as we obtain feedback from end-users. As well as conducting individual training workshops for each of the Toolkit products, we will be running at least one major Catchment Modelling School per year, the first to be held in February 2004. We are currently undertaking a needs-analysis for the Catchment Modelling School and will be releasing program details in September 2003. Some of our university-based researchers are also investigating how to use various Toolkit models in undergraduate teaching curricula.

Industry Affiliates

Under our 'Industry Affiliate' arrangements, we are establishing strategic relationships with some of Australia's leading environmental engineering consultants. Here, our goal is to get the consulting industry testing our tools in challenging 'real-world' situations and to give us feedback on the operability of those tools. To date, we have had a very successful working relationship with WBM Oceanics who have applied our EMSS and MUSIC models quite extensively. Now, we are negotiating with three potential new Industry Affiliates to extend our reach within the consulting industry even further.

Encouraging co-developers to join us

One of the foundation stones of the Catchment Modelling Toolkit is a model development framework known as TIME (The Invisible Modelling Environment). We have built this to simplify and standardise the task of model development and to provide a means of linking models together. For us, TIME has been a necessary technological breakthrough. It is the tool we needed to integrate discrete models committed by our CRCs various specialist teams. However, it is also a most useful tool for the rest of the land and water R&D community to start working collaboratively on modelling projects. We are now eager to attract researchers based outside our CRC and encourage them to adopt TIME as their preferred model development environment. We are also encouraging them to commit the fruits of their labours to the Catchment Modelling Toolkit so that their work can be readily accessed by others.

We've been heartened by the various Industry Affiliate and model co-developer relationships we have formed so far, but we seek an even broader engagement.

Please give us a call if you'd like to join us. I urge you to keep your eye on *Catchword* for the 'official release' of the Catchment Modelling Toolkit website due in the next few months. Through our communication and training initiatives we will be actively trying to help you in getting started with the toolkit and its products.

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CRC PROJECT PORTFOLIO (2003-2005)

The CRC has published a 'Project Portfolio' which gives readers an overview of the CRC, its mission and short summaries of all new CRC projects (2003-2005). A copy is included with this edition of *Catchword*.

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

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

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

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader GEOFF PODGER

The Integration of Industry Models

At a glance - a summary of this article

This article discusses the strategy for integration of the CRC's industry participants' river models (IQQM and REALM) into the CRC's Catchment Modelling Toolkit.

Hydrologic models

Some of the CRC for Catchment Hydrology industry participants, namely Queensland Department of Natural Resources and Mines (QDNRM), New South Wales Department of Sustainable Natural Resources (DSNR), Victorian Department of Sustainability and Environment (DSE), Goulburn-Murray Water (GMW) and the Murray Darling Basin Commission (MDBC) use hydrologic models to assess the impacts of water resource management policies on water users. In some cases these models are also used for river operations.

Currently there are three models used by the industry Parties:

- the Integrated Quantity and Quality Model (IQQM)
- the Resource ALlocation Model REALM
- the Big Model-Monthly Simulation Model (BM-MSM).

IQQM is used by QDNRM and DSNR and has been adopted by MDBC to replace their existing modelling suite BM-MSM. REALM is used in Victoria by DSE and GMW. IQQM and REALM have also been used by various consultants and applied in many different areas.

IQQM overview

IQQM is a hydrologic modelling tool developed by DSNR (formerly Department of Land and Water Conservation), with collaborative assistance from the QDNRM. It is intended for use in investigating the impacts of water resource management policies or policy changes on stakeholders. IQQM can be applied to river systems with and without dams, and is designed to be capable of addressing water quality issues as well as water quantity issues. It can also be used to investigate new water resources developments or modifications to existing developments.

The model operates on a continuous basis and can be used to simulate river system behaviour, including water quality, for periods of hundreds of years. It is designed to operate at a daily time step, but some processes can be simulated at time steps down to one hour. Further information can be found at www.dlwc.nsw.gov.au/care/water/pdfs/iqqm1999.pdf.

IQQM has been applied throughout NSW and Queensland and has also been applied to several river systems outside of Australia including the Mekong River.

REALM overview

The REALM package was originally developed by DSE. Since 1997, program maintenance and support has been out-sourced to the Victoria University of Technology. REALM is a generalised computer program that simulates flow and salinity in simple water supply systems as well as large and complex ones on a continuous basis. It uses a fast network linear programming algorithm to optimise the water allocation within the network during each simulation time step which can be monthly, weekly or daily. It can be used as a 'what if' tool to address various options including new operating rules and physical system modifications. A wide range of operating rules can be modelled either directly or indirectly by exploiting the basic set of node and carrier types. Further information can be found at www.nre.vic.gov.au/web/root/Domino/vro/vrosite.nsf/pages/water-surfacemod.

REALM has been applied throughout Victoria and has also been applied in South Australia and Western Australia.

REALM and IQQM are similar in that they are used to address water quantity issues, however, the models differ in how they are operated. IQQM was designed to be a daily model and as such deals with routing and is controlled by operational rules which accumulates water orders in an upstream direction then routes releases and tributary flows downstream. IQQM also models water quality. REALM was built as a monthly model to simulate large integrated systems where demand centres have many alternative sources of supply, but is capable of daily operation. It uses a network linear program to optimise the supply of water subject to operational rules and system constraints. REALM can apply only very basic routing and can model up to four conservative water quality parameters.

Integration

There has been information provided in previous editions of *Catchword* about the tools that the CRC for Catchment Hydrology is planning to develop and release over the next few years. There was an article in the February 2003 edition that described how these tools are going to be developed in 'The Invisible

Modelling Environment' (TIME). For industry to be able to utilise these tools with existing models it is necessary that the industry models can work within TIME. This is not an easy task as the industry models are not written in a way that allows them to be readily put into TIME. Models such as IQQM and REALM are large, and converting them across to TIME would be a difficult task.

Language for Models

Our strategy to solve this integration problem is to develop a language that will allow TIME and the industry models to communicate with each other. This requires some development of the industry models as well as a module in TIME that handles the exchange of information. The language will support the opening of model configuration files, changing model inputs and a subset of parameters, saving model configurations, running the model and accessing the model output.

IQQM already has a macro language that was developed to integrate IQQM with a Decision Support Framework (DSF) developed by Halcrow as part of the Water Utilisation Programme for the Mekong River Commission. The DSF allows non-IQQM modellers to create and run scenarios via a simplified interface. The DSF allows an exchange of information between a knowledge base, a catchment model (in this case, SWAT) and a hydraulic model (ISiS). This concept of connecting models together is similar to what can be done in the TIME environment. Work has also begun on developing up a similar language for REALM.

TIME integration module

The TIME integration module will allow other models developed in TIME to change and access information contained in the industry models without having to understand the format or structure of the configuration files. It will allow TIME to control the running of the industry models. An example of this could be the linking of an economic model to IQQM. The economic model could inquire about available water resources predicted by IQQM and based on this information the economic model would decide on where water trade should occur and what type of crops should be grown to maximise profit. In this example, IQQM could be parameterised, run and evaluated via the TIME integration model, requiring no familiarity with the existing IQQM interface.

Conclusion

The integration of existing industry models into TIME will enhance the ability of the land and water industry to utilise the CRCs Catchment Modelling Toolkit. Over time, components from the industry models will be ported across into TIME. This will allow modelling applications to be developed within TIME that are capable of doing many of the things that industry models can currently do. The industry models will continue to support industry needs in the shorter term but in the longer term it is hoped that TIME-built applications will build on and enhance the capabilities of industry models.

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FOREST MANAGEMENT WORKSHOP AND FIELD DAY - CANBERRA

RE-SCHEDULED FOR 9-11 DECEMBER 2003

The recently promoted Forest Management workshop arranged through a partnership between the University of New South Wales, NSW State Forests, the Forest Science Centre and the CRC for Catchment Hydrology has been re-scheduled for the 9-11 December 2003.

Four major themes will be addressed during the first two days of this workshop:

- Forest Hydrology
- Sediment Delivery and Water Quality
- Fire Management
- Sustainable Forestry

The third day will be a field trip for participants to visit the burnt forest west of Canberra and NSW State Forest plantations near Tumut.

For further information regarding the workshop and how to register as a presenter or participant please contact David Perry on 03 9905 9600 or email david.perry@eng.monash.edu.au

OTHER OUTLETS FOR CRC PUBLICATIONS

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

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

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

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Mark Littleboy

Project 2C: Predicting Salt Movement in Catchments

Background

Project 2C: 'Predicting salt movement in catchments' is a newly funded project in the second round of projects in the CRC for Catchment Hydrology. The project evolved from workshops on priority research directions held over twelve months ago and the proposal was developed within the Program 2 Technical Advisory Group and other integration activities last year.

Project aim

The objective of 2C is to develop a salt balance model as part of the modelling toolkit. This will enable CRC Industry Parties to provide consistent output as part of their State, Murray-Darling Basin and national investment, catchment planning and reporting mechanisms.

The project will develop a consistent predictive capability to:

- quantify surface and groundwater contributions of salt to catchment scale salt export;
- predict the impacts of land use change in salt movement at a catchment scale;
- link with other models within the CRC Catchment Modelling Toolkit to predict of the impacts salinity management scenarios on downstream water allocations, environmental flows, and their contributions to end-of-valley salinity targets; and
- demonstrate the capability of the model through application in three CRC for Catchment Hydrology focus catchments.

Current salt balance models

There is a variety of salt balance models currently being developed and applied in eastern Australia. These modelling activities generally lack integration across all agencies and organisations. Different models operate at different spatial and temporal scales and at varying stages of development and application. Existing activities such as the CSIRO Biophysical Capacity to Change Model, the NSW Dept of Sustainable Natural Resources (formerly DLWC) CATSALT model, the Victorian Dept of Sustainability and Environment (formerly DNRE) CAT model and the Qld Dept of Natural Resources and Mines salinity hazard/risk mapping are examples of salinity models that are currently under development across CRC Parties. These different approaches have evolved from previous research activities and reflect data availability, skills within those organisations and organisational priorities.

Developing consistent approaches

The lack of a consistent salt balance modelling approach across eastern Australia has led to anomalies in model output along State borders and results that cannot be readily compared across States - a key limitation for reporting mechanisms at Murray-Darling Basin and national scales. Project 2C focuses on development of a consistent salt balance modelling approach that can be applied by the CRC for Catchment Hydrology Parties at a catchment scale across eastern Australia. This enables State Agencies to provide consistent predictions on salt movement to the MDBC and Federal Agencies and will better align State and Commonwealth salinity modelling activities.

Need for predictive capability

This type of model is critical to guide investment decisions, catchment planning activities and future saltloads trends analyses under State, Murray-Darling Basin and national strategies. In eastern Australia, salinity management planning is underpinned by the concept of a future salt target. Intervention strategies (eg land-use changes) are designed and implemented so that a catchment may achieve its target. There is an urgent need to develop a predictive "cause and effect" capability so that the contributions of different intervention strategies on achieving catchment targets can be quantified. Therefore, to support these strategies, salinity models must reflect the impact of land-use changes within a catchment on salt export from that catchment.

Model features

At a preliminary meeting of project participants held last year, a number of generic design specifications were formulated. The model will:

- focus on dryland salinity processes rather than irrigation salinity for catchments up to around 2000 km^2;
- predict the impacts (salt export and groundwater response times) of land use changes across broad management units within a catchment
- provide connectivity between surface and groundwater processes;

- partition the surface and groundwater pathways of water and salt by linking salt movement to connected lumped catchment hydrology (eg Sacramento) and the CSIRO FLOWTUBE groundwater models;
- build on existing Groundwater Flow Systems concepts; and
- operate on a daily timestep

Project Activities

The first major activity in 2C is to conduct a workshop to review existing salt movement models and develop design specifications for the CRC for Catchment Hydrology salt movement model. The workshop will include the project team, representatives from other relevant CRC projects, and independent technical expertise. The workshop is scheduled for late May 2003. Following this workshop, a CRC report containing the detailed design specifications will be prepared by July. In late June, the interim results from this workshop will be presented to the Murray-Darling Basin Commission Salinity Modelling Forum.

Following the development of the design specifications, the project will:

- develop the initial version of the salt movement model and incorporate it within the modelling toolkit;
- validate the model by applying it in three CRC for Catchment Hydrology focus catchments;
- evaluate and further refine the model; and
- develop spatial generalisation techniques so that the model can be applied across eastern Australia

Skills and support

The in-kind contributions across the four project Parties bring an extraordinary range of expertise, skills and experience to the project. In addition, the project will partly fund either new or existing positions across all project partners.

The level of support for this project is considerable. Almost 70% of the total project budget is sourced from in-kind contributions, reflecting the project participants' enthusiasm for this project. The Murray-Darling Basin Commission views 2C as a key activity under their strategies and has become a major funding participant, supplying 21% of the total project budget as a cash contribution. The CRC is directly funding the remaining 11% of the project.

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You can use our search engine to find the exact report you are seeking or to list all of the reports available.

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

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

By
André Taylor
Tony Wong

Technical Report 02/11

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

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

PROGRAM 3
SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Erwin Weinmann and Sergei Schreider

Integrating water allocation and economic models for the Goulburn-Broken catchment

Project background

Effective assessment of alternative water allocation policy and management options requires that both the physical and economic characteristics of the system are adequately considered. So far the modelling of these two aspects of irrigated agriculture systems has been treated separately, by different project teams using different system representations and different space and time scales. It is the task of Project 3A: 'Integrating water allocation and economic models for water allocation' to integrate the two modelling approaches to provide an enhanced modelling capability to the industry parties responsible for formulating and implementing water allocation policies. Within this broader project framework, a major part of the project (Activity 3) concentrates on the Goulburn-Broken catchment in Victoria. This activity is being undertaken by researchers at Monash University and The University of Melbourne in conjunction with experts from the Department of Sustainability and Environment (DSE), the Department of Primary Industries (DPI) [formerly both part of the Victorian Department of Natural Resources and Environment] and Goulburn-Murray Water (GMW).

Current modelling capabilities

- Physical modelling

In the Goulburn-Broken focus catchment, the Goulburn Simulation Model (GSM) has evolved over a number of years to provide a representation of the physical system characteristics and water allocation and operational rules which meets the requirements of the two water management agencies involved, the DSE and GMW. The GSM was built using the generalised computer simulation package REALM (REsource ALlocation Model). The model extends beyond the Goulburn-Broken catchment to cover also the Campaspe and Loddon catchments which form part of an integrated rural water supply system in Northern Victoria. It simulates the operation of this complex system, which includes many separate inflows, a total of 20 storages and 58 demand areas, and allows allocation of supply to the different water demands in accordance with a set of rules and constraints. Simulation in the GSM is at a monthly time step and extends over 110 years of historic streamflow, rainfall and evaporation data to reflect the impacts of highly variable climate conditions on water demand and supply. The irrigation water requirements of the crops established at the different irrigation demand nodes are estimated externally to the GSM using the Program for Regional Irrigation Demand Estimation (PRIDE).

- Economic models

Economists in the Department of Primary Industry have played a major part in the development and application of regional economic models for the southern part of the Murray-Darling Basin. The approach involves two component models: Regional Linear Programming (LP) Models for each of the regions to estimate their economic water demand and supply characteristics, and a Spatial Equilibrium Model to allow the estimation of water transfers between the regions. These models are currently applied at a spatial scale that is considerably larger than the irrigation areas represented by GSM demand nodes. The models focus on economic inputs and outputs over a whole growing season or year.

- Regional impacts

Project 3A also envisages the use of a regional input-output model to allow regional impact assessment of various scenario options. CSIRO Sustainable Ecosystems have recently constructed a 32 sector input-output model for the Goulburn-Broken catchment as part of a project for the Goulburn-Broken Catchment Management Authority, and negotiations for the use of this model within the project are currently under way.

Research gaps to be addressed

Adaptation and closer linking of the above physical water allocation simulation models and economic models is required to achieve the following additional modelling capabilities:

- simulating irrigator response to variations in seasonal water availability/allocation (including temporary water trading), as a basis for adjusting PRIDE-estimated monthly irrigation demands used in the GSM
- producing economic measures of farm output from irrigated agriculture sectors as a basis for comparing alternative water allocation policy scenarios
- assessing broader regional impacts of water allocation scenarios through an input-output model.

The main challenges in developing these additional modelling capabilities relate to bringing together models that operate at different space and time scales without introducing inconsistencies and sacrificing essential detail in the representation of the physical, operational and regulatory constraints that the real system imposes on the interplay of demand and supply. The current work benefits from previous work undertaken as part of Project 3.1 and a PhD project undertaken by A H Wijedasa at The University of Melbourne (as CRC Associated/Additional Project 3.6).

Adopted approach

Given the major differences in the characteristics of irrigated agriculture and the water supply systems in the two focus catchments initially to be examined in Project 3A, as well as the models currently used to represent them, it is not surprising that somewhat different approaches are necessary for achieving the project objectives in the Murrumbidgee and Goulburn-Broken catchments. The approach for the Goulburn-Broken catchment, which has been developed through a series of discussion meetings between the major stakeholders, incorporates the following key elements:

- adaptation and application of the Regional LP modelling approach developed by the DPI to estimate economic water demand and supply curves for the GSM demand nodes which reflect the influence of different seasonal climate conditions
- adaptation of the GSM to link and run dynamically with economic models on a yearly basis - in a first run to simulate demand and supply in the absence of water trading, then in a second run, following the application of the Spatial Equilibrium Model, to ensure that all system constraints are considered with temporary water trading
- application of the Spatial Equilibrium Model developed by DPI to balance trade between nodes for the season subject to the regulatory constraints currently applied, as a basis for adjusting the monthly irrigation water demands used in the GSM
- enhancement of GSM outputs to provide indicators of irrigated agriculture outputs and to link with the regional input-output model.

Current work and outlook

Now that the conceptual approach has been bedded down, the project team is getting very busy in developing the individual program modules and data sets to allow these concepts to be implemented. Once the modelling enhancements have been developed and tested for the specific case of the GSM, it is intended to bring them progressively into the CRC's Catchment Modelling Toolkit to allow their broader application with REALM based water allocation models.

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NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

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

By
André Taylor
Tony Wong

Technical Report 02/12

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

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

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - NEW REPORTS

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

By

André Taylor

Tony Wong

Technical Report 02/13

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

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

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader

TIM FLETCHER

Report by André Taylor and Tim Fletcher

Assessing Stormwater Management Measures Using a 'Triple Bottom Line' Approach

Stormwater management decisions

Urban stormwater managers across Australia are increasingly being asked to make important decisions, such as the selection of appropriate stormwater management measures, within the framework of 'triple bottom line' analysis. That is, they must consider the ecological, social and economic costs and benefits of various options, in addition to water quality and quantity issues.

Figure 1 summarises the many forms of costs and benefits that are potentially associated with a given urban stormwater management measure, such as a constructed wetland or gross pollutant trap. Unfortunately, traditional decision-support tools such as 'cost benefit analysis' are inappropriate and/or impractical when stormwater managers attempt to incorporate the social and ecological costs and benefits shown in Figure 1 into the decision-making process. New tools are needed.

New project on decision tools

In response to this predicament, the CRC has started a new two-year Associated/Additional Project titled "Tools for Evaluating the Economic and Social Performance of Stormwater Management Measures". Funding for the project has been kindly provided by the Victorian Stormwater Action Program, Brisbane City Council and Melbourne Water.

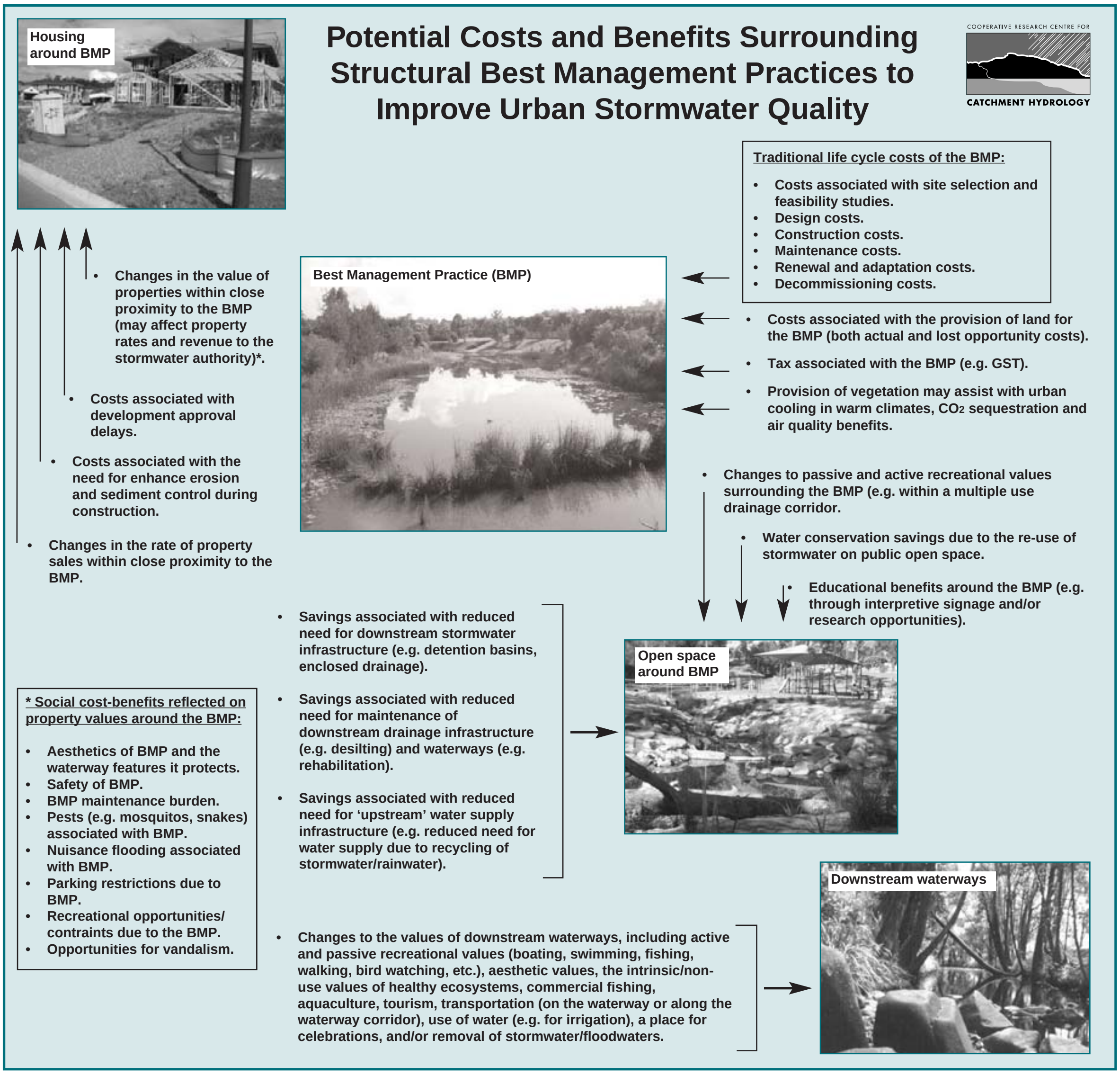

Figure 4.1 Summary of costs and benefits potentially associated with a given urban stormwater management measure

The project has been structured in three stages.

- Life cycle costing

During the first stage, a life cycle costing module will be built into the CRC's MUSIC model to assist urban stormwater managers to quickly undertake 'traditional life cycle costing'. That is, the module will consider acquisition costs (e.g. costs associated with site selection processes, feasibility studies, grant applications, designs and construction), routine maintenance costs, renewal and adaptation costs (i.e. significant post-construction alterations to the management measure), and decommissioning costs.

- Assessment guidelines

During the second and third stages, assessment guidelines will be developed and trialled that allow 'externalities' to be assessed in addition to traditional life cycle costing. An 'externality' in this context can be defined as a cost or benefit that arises from an economic transaction (e.g. the construction of a wetland) and falls on people who don't participate in the transaction (e.g. people living next to the wetland). These costs/benefits may be positive or negative and the assets affected may be tangible (i.e. have markets) or intangible. Stage 2 will focus on those externalities that are simpler to assess, while Stage 3 will tackle the more challenging externalities.

- Project outcomes

The outcome of this project will be decisions on urban stormwater initiatives that better reflect the three core objectives of stormwater management agencies. Namely to:

- protect and enhance the ecological health of waterways;
- protect and enhance the social well-being of citizens; and
- use public resources in an efficient and accountable manner.

Ideas and comments on this project will be warmly welcomed.

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CRC STORMWATER MANAGEMENT SHORT COURSE

Stormwater Management and Water Sensitive Urban Design

30 June - 4 July 2003

This course targets stormwater industry professionals in a number of roles including catchment planning and management, stormwater infrastructure design, construction, operation and maintenance.

The course is presented over five days and includes a day in the field inspecting urban stormwater quality improvement facilities and water sensitive urban design. The course is divided into two parts (A and B) to allow participants to choose their level of participation. A comprehensive set of course notes is provided.

The workshop is limited to 40 participants and places will be allocated in order of receipt of registration forms.

For further information contact Virginia Verrelli at the CRC Centre Office by email: crcch@eng.monash.edu.au or visit the CRC web site www.catchment.crc.org.au/news

NEW WORKING DOCUMENT

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

by
Lionel Siriwardena
Francis Chiew
Harald Richter
Andrew Western

Working Document 03/1

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

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

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

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Harald Richter, Francis Chiew and Andrew Western

Improving the land surface scheme of the Australian numerical weather prediction models

Background - Project 5A

One of the aims in Project 5A: 'Hydrological modeling for weather forecasting' is to improve the land surface modelling and the initialisation of surface variables (in particular soil moisture) in numerical weather prediction models. This should lead to improved weather forecasts, particularly rainfall, that can be used by water agencies for better flood forecasting and operational water management.

Role of land surface schemes

Numerical Weather Prediction (NWP) models receive their lower boundary information from land surface schemes (LSS). These schemes primarily convert NWP model forcings such as rainfall and radiation into heat and moisture fluxes that are fed back into the NWP model. It is not surprising that the land surface fluxes into the NWP model are sensitive to the soil and vegetation properties used within the LSS. Furthermore, NWP model fields themselves are sensitive to the land surface fluxes. This holds true especially for rainfall (e.g. Beljaars *et al.*, 1996), particularly in the transition zones between humid and dry climates (Koster *et al.*, 2000), the movement of wind shift lines (Mills, 1995) or fog and low cloud prediction (Bergot and Guedalia, 1994).

The operational Australian land surface scheme

The current LSS used in some of the operational NWP models of the Bureau of Meteorology was developed by Viterbo and Beljaars (1995) (hereafter VB95). Generally the LSS uses globally uniform soil and vegetation parameters, potentially leading to flux errors, especially given the uniqueness of Australian vegetation. It is likely that VB95 will soon be coupled to the entire suite of operational NWP models which operate on domains ranging in size from southeast Australia up to the entire globe with spatial horizontal grid cell sizes of 5-75 km (see also February 2002 *Catchword*).

A land surface scheme with variable soils and vegetation

In order to relax the assumption of globally uniform soil and vegetation parameters, present in the current LSS, specific soil and vegetation parameters were derived from the Atlas of Australian soils and satellite-based remotely sensed vegetation properties. This was done at a number of point locations around the Murrumbidgee catchment in southern NSW. These point locations coincide with the locations of soil moisture and soil temperature monitoring stations which have generated soil moisture and soil temperature datasets since September 2001 (see June 2002 *Catchword*). We will refer to the use of the site-specific soil and vegetation parameters as the 'variable soil' (varsoil) and 'variable vegetation' (varveg) cases. The uniform soil and vegetation parameters will be referred to as 'default soil' (defsoil) and 'default vegetation' (defveg). More details about the Murrumbidgee monitoring program can be found in Western *et al.* (2002).

Experimental setup

To test the behaviour of VB95 with and without variable soils and vegetation parameters we conducted stand-alone runs of VB95 at point locations in the Murrumbidgee. The climate forcing data were derived from the Bureau of Meteorology Automatic Weather Stations observations (Siriwardena *et al.*, 2003).

Sensitivity of the annual land surface scheme water budget

Figure 5.1 illustrates the effect of variable soil texture and vegetation on the annual water budget at ten different Murrumbidgee sites in the period 1 December 2000 - 30 November 2002. Each site-specific histogram shows the two-year average of the annual precipitation (first column) and the annual evapotranspiration (ET; from VB95) for the defsoil+defveg case (second column), the defsoil+varveg case (third), varsoil+defveg case (fourth) and varsoil+varveg case (final column).

For 25 out of 40 simulations shown in Fig. 5.1, the soil water loss through evapotranspiration in the Murrumbidgee, outweighs the water input through precipitation. The additional water needed for the ET comes from storage depletion. There are clear differences between the simulations with each parameter set. Soil parameters cause greater changes in the simulated annual ET than vegetation parameters evident in the larger differences between columns 2 and 4 as opposed to columns 2 and 3.

A more detailed budget analysis shows that at the drier (western) sites of the Murrumbidgee, the usage of varveg parameters in the LSS leads to a significant reduction in simulated root extraction (less transpiration), but an even larger increase in bare soil evaporation. The reverse is true for the five eastern sites where a significant reduction in root extraction generally dominates an increase in bare soil evaporation resulting in lower total ET.

Land surface scheme output comparisons with observations

The Murrumbidgee catchment soil moisture and soil temperature observations have been used to assess the VB95 output quality at 10 point locations. In general, VB95 can model the temporal fluctuations in soil moisture, and therefore the moisture fluxes, realistically. However, the model exhibits a significant bias in the absolute soil moisture and soil temperature highlighting the need to improve our estimates of soil and vegetation properties for modelling applications and possibly the model forumlation.

Figure 5.2 shows comparisons between observed soil moisture and modelled values from the defsoil+defvar and varsoil+varveg runs for Cooma. During the period 11 September 2001 and 31 May 2002.

Model performance

In general, VB95 is able to simulate the temporal dynamics of soil moisture in terms of timing and amplitude well at nearly all sites. This suggests that the available soil water and consequently evapotranspirative fluxes (into the NWP model) are also modelled fairly well.

Similar to most other Murrumbidgee sites, there is a tendency for a wet bias in the surface layers at Cooma. Cooma also shows a strong dry bias in the deeper layers, while generally there is a mix of deep-layer wet and dry biases at other sites.

The bias in the soil moisture is likely to be primarily related to a high bias of the model soil water content at which plants can start transpiring (permanent wilting point or _pwp). This high bias is evident from soil moisture measurements that often show soil moisture values that lie below the permanent wilting point as specified in VB95.

An important implication of the high bias of _pwp in the model is the likely failure of initialising VB95 with measured soil moisture. Observed (low) soil moisture values combined with a high _pwp would lead to very low model ET, while the dry-down behaviour of the measured soil moisture in Fig. 5.2 suggests periods of significant ET in nature. Consequently, the soil moisture initialisation of VB95 must key on the soil water availability (soil water in excess of _pwp) rather than the absolute value of soil moisture.

In summary, using soil parameters based on the Atlas of Australian soils and vegetation parameters based on remote sensing leads to appreciable differences in soil moisture and ET, but it does not lead to a consistent improvement in the soil moisture simulations.

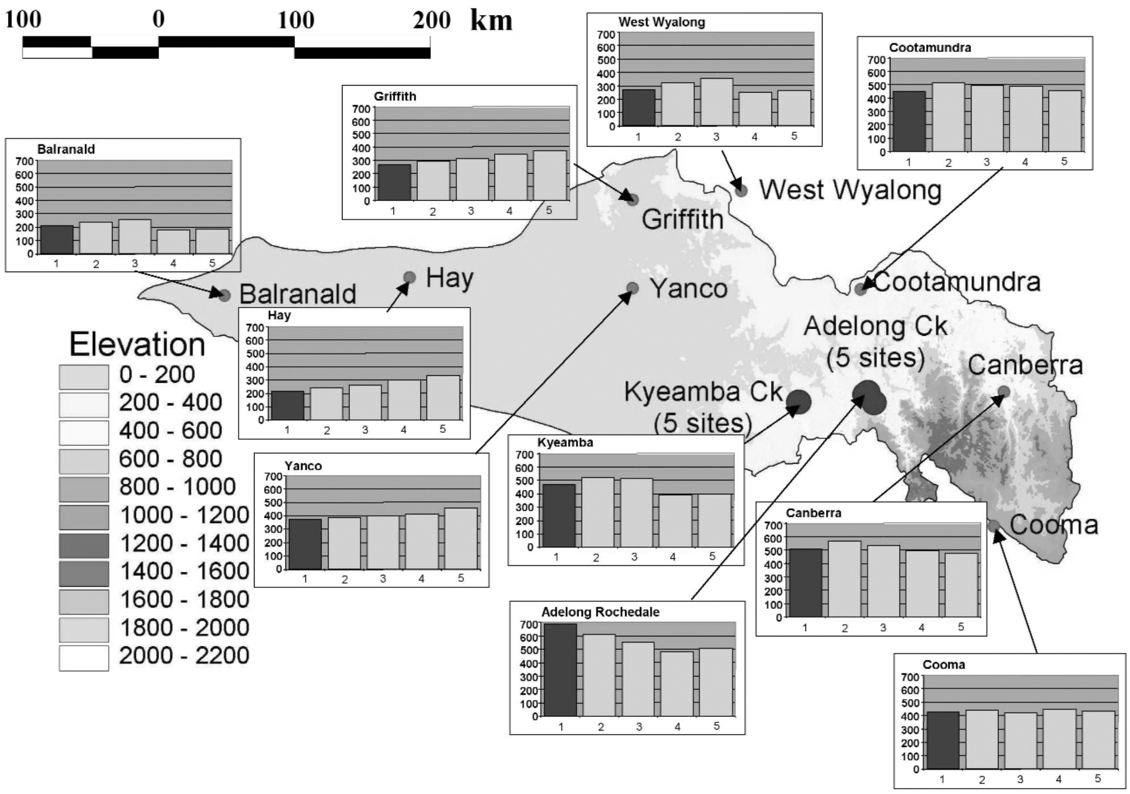

Figure 5.1. The eighteen sites where measurements of soil moisture, temperature and suction are recorded. The large dots mark clusters of 5 individual sites in gauged catchments. The column charts show the dominant components of the annual water budget for 10 individual soil moisture stations in the Murrumbidgee averaged over the period 01 Dec 2000 to 31 Nov 2002. The first column in each histogram marks the measured precipitation (in mm), columns 2-5 represent simulated evapotranspiration for (2) default soil and vegetation, (3) default soil and variable vegetation, (4) variable soil and default vegetation and (5) variable soil and vegetation.

WEATHER RADAR CONFERENCE

Sixth International Symposium on Hydrological Applications of Weather Radar

2-4 February 2004
Melbourne, Australia

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

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

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

HYDROLOGIC IMPACTS OF BUSHFIRES WEBSITE

In response to many requests for information about the hydrologic impacts of the recent bushfires, the CRC has established a website to deliver relevant information to catchment and water supply managers.

The site is a modest resource at this point and will evolve as more contributions are made. The site initially features a FAQ section designed for land and water managers, an overview of the hydrologic impacts of fire, a news page for information about related activities and reference lists that will be of particular interest.

The site can be found at www.catchment.crc.org.au/bushfires

The CRC welcomes contributions from all individuals and organisations to the site to expand its value to land and water managers.

If you can contribute to this site please contact david.perry@eng.monash.edu.au

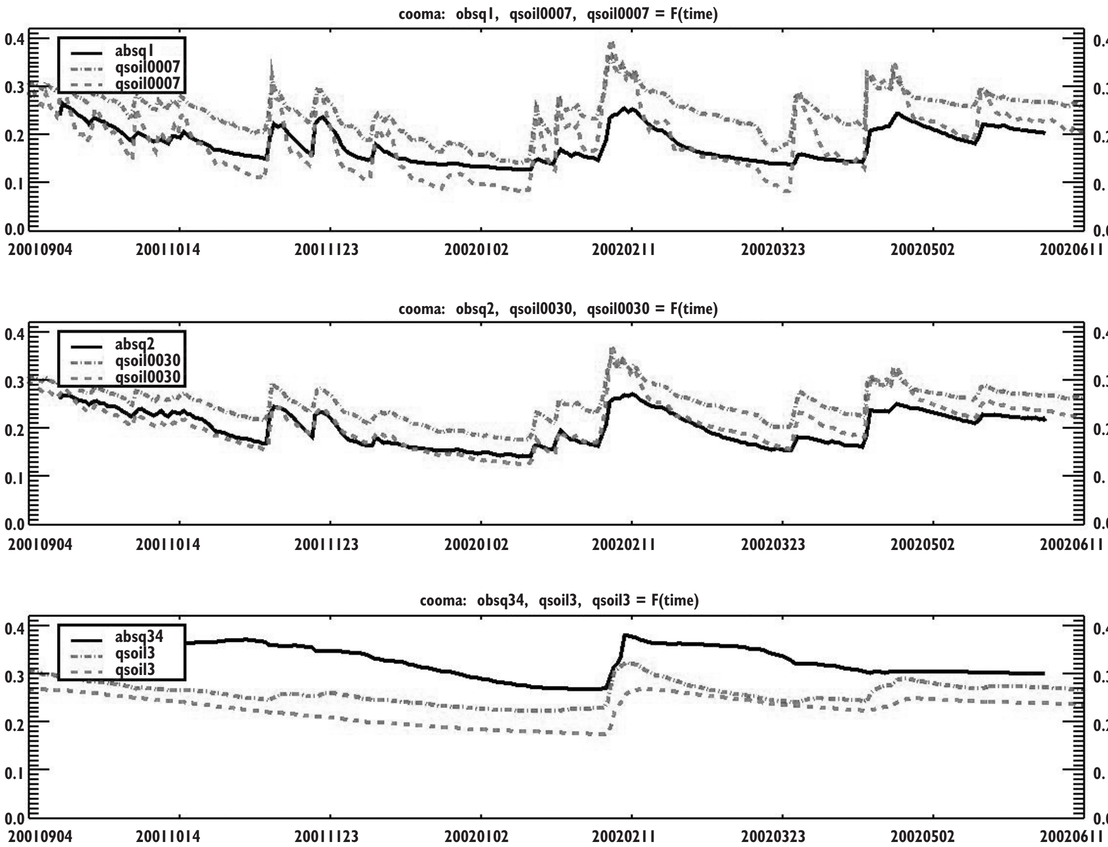

Figure 5.2. Volumetric soil moisture comparisons at Cooma between 04 September 2001 and 11 June 2002. The three panels show results for the soil layers 0-7 cm (top panel), 0-30 cm (centre panel) and 30-90 cm (bottom panel). The solid line is the observed volumetric soil moisture, the dot-dash line the model moisture for the defsoil+defveg run, and the dashed line the model moisture for the varsoil+varveg run.

Future work

Future work on the land surface modelling will include assessing VB95 as used operationally in the NWP (i.e., simulation out to four days), improving the hydrology in VB95 particularly improving the flowpath representation and incorporating spatial representation of hydrological processes and assessing the impact of improvements to VB95 on weather forecasting.

References

Beljaars, A.C.M., Viterbo, P., Miller, M.J. and Betts, A.K., 1996. The anomalous rainfall over the United States during July 1993: Sensitivity to land surface parameterization and soil moisture. Monthly Weather Review, 124(3): 362-383.

Bergot, T. and D. Guedalia, 1994: Numerical forecasting of radiation fog. Part I: Numerical model and sensitivity tests. Mon. Wea. Rev., 122, 1218-1230.

Koster, R.D., Suarez, M.J. and Heiser, M., 2000. Variance and predictability of precipitation at seasonal-to- interannual timescales. Journal of Hydrometeorology, 1(1): 26-46.

Mills G.A., 1995: The Enfield fire - LAPS model results. Proceedings, 6th Fire Weather Workshop, Hahndorf, South Australia, 18-22 June 1995. Bureau of Meteorology, PO Box 1289K, Melbourne VIC 3001, Australia.

Siriwardena, L., F. Chiew, H. Richter and A. Western, 2003: Preparation of a climate dataset for the Murrumbidgee River Catchment. Cooperative Research Centre for Catchment Hydrology, Working Document 03/01.

Viterbo, P., and A. C. M. Beljaars, 1995: An improved land surface parameterization scheme in the ECMWF model and its validation. J. Climate, 8, 2716-2748.

Western, A. W., H. Richter, F. H. S. Chiew, R. I. Young, G. Mills, R. B. Grayson, M. Manton and T. A. McMahon, 2002: Testing the Australian Bureau of Meteorology's land surface simulations using soil moisture observations from the Murrumbidgee Catchment. Hydrology and Water Resources Symposium 2002 [CD-ROM], IE Aust, Melbourne, Australia. 10pp.

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PROGRAM 6
RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Nick Marsh and Mike Stewardson

Introducing the River Analysis Package (RAP)

Assisting river managers

The River Restoration Program is developing the River Analysis Package (RAP) to assist river managers to undertake:

- Condition assessments,
- Environmental flow planning and
- River restoration design.

Modules and their use

The final version of RAP will have four key modules:

- Hydraulic analysis
- Time series analysis
- Rules models of ecological response to flow
- Quantitative models of ecological response to flow

The first version of RAP (Beta version due to be released within two months) will include the Hydraulic Analysis and Time Series Analysis modules (see sample screen shots in Figures 6.1 and 6.2). We expect these tools to be of use in a range of applications, and particularly useful for environmental flow studies.

Hydraulic Analysis Module

The Hydraulic Analysis module (HA) provides tools for examining hydraulic characteristics of river channels. The Hydraulic Analysis module has some neat graphical features that make it easy to explore hydraulic conditions at channel cross-sections. The HA module can calculate the standard cross-sectional attributes such as surface width, area, hydraulic radius and wetted perimeter. It is also possible to define habitat criteria and calculate the area of habitat at a range of discharges. The HA module can read HECRAS output files or users can enter their own channel geometry data.

Time Series Analysis Module

The Time Series Analysis (TSA) module has been designed to calculate summary metrics of daily discharge data, however it can handle other forms of time series data such as time series hydraulic data output from the HA module. The range of statistics calculated by the TSA module has been informed by a review of the literature, focusing on hydrological statistics used in ecological studies. The TSA module can present summary statistics based on the entire period of record, annually, seasonally, or monthly depending on the specific issue being investigated. The TSA module includes spell analysis, rates of hydrograph rise and fall, the prediction of flood return interval (partial and annual series), baseflow (Lyne and Hollick), seasonality (Colwells and Haines methods). In addition to the numeric output, the TSA module has some useful visualisation tools for plotting flow duration curves, flood frequency curves, and baseflow vs floodflow.

Subsequent modules

The subsequent modules of RAP are based on providing tools for interpreting the likely biological response of alternative flow scenarios. These subsequent modules are based on the outcomes of the joint CRC for Catchment Hydrology Project 6A / CRC for Freshwater Ecology Project A2 activity on "Developing flow-ecological response models". The subsequent modules will utilise the underlying capability of the TSA and HA modules to calculate hydrologic and hydraulic characteristics that have specific biological relevance.

Commercialisation aspects

In addition to providing an analytical tool, RAP is also intended as a tool for communication between technical teams and stakeholder groups. It has the flexibility to be able to explore the data and different operational scenarios during a workshop or as part of a presentation to project stakeholders. This is likely to be useful where there are experts from a range of disciplines working on a project or where community groups want to understand the technical basis of project recommendations.

Web based information

RAP will also be part of a web-based information system that will be an important pathway for the delivery to river managers of new research results from the CRC for Catchment Hydrology and partner projects in the CRC for Freshwater Ecology. For example, the CRC's plan to provide a library of flow-ecology models as part of RAP within the next 12 months. It is the CRC's hope that this tool will be used nationwide and streamline the delivery and adoption of research outcomes over the coming years.

Testing procedure

We are taking RAP through a thorough testing procedure before it will be made generally available. This process includes initial preliminary consultation with potential users. Feedback from our first review panel meeting in Melbourne in February 2003 was extremely

NEW TECHNICAL REPORT

Evaluation of Two Daily Rainfall Data Generation Models

by

Lionel Siriwardena
Ratnasingham Srikanthan
Tom McMahon

Technical Report 02/14

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

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

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positive. Since then, two panel members have offered to use the software in an environmental flow project as a preliminary trial, under fire. A beta version of RAP is due to be completed shortly. This will be trialled by a limited a number of practitioners who have expressed interest in the software and have an immediate need for RAP. We would like to include people from different regions in this trial. If you have an interest in this please contact Nick Marsh. These users will provide feed back on functionality and any final bugs. Once the concerns of these beta-testers have been addressed we will load RAP onto the CRC's Catchment Modelling Toolkit website for distribution.

General release

The general release of RAP will be widely advertised including announcements on the CRC Catchment Modelling Toolkit web site, in the CatchUp newsletter and in *Catchword*. This version of RAP will be at no charge. Later versions will be released as we build in more functionality and additional modules. We will be holding seminars to introduce RAP and training courses over the coming year. For more information contact Nick Marsh.

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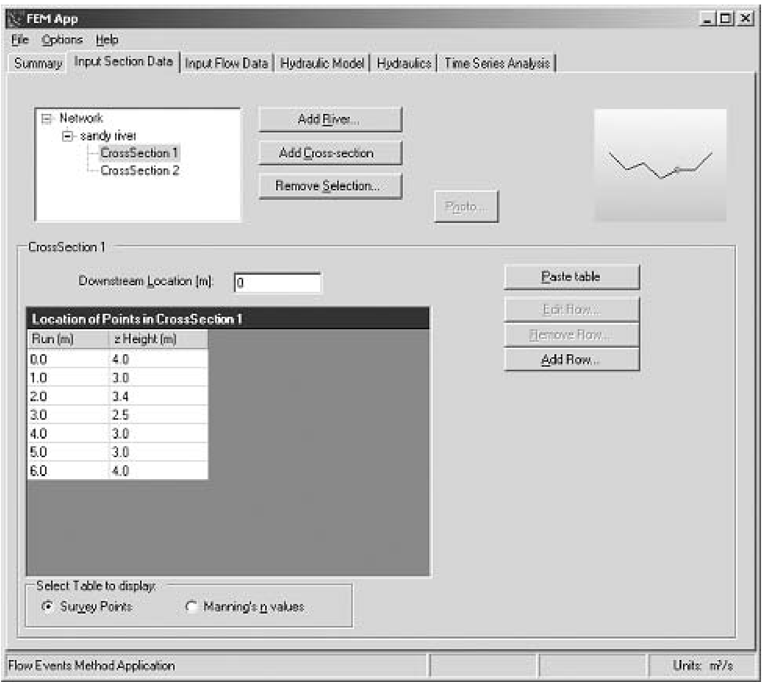

Figure 6.1 Hydraulic analysis:- Example of the Hydraulic Analysis interface showing channel cross-section input interface.

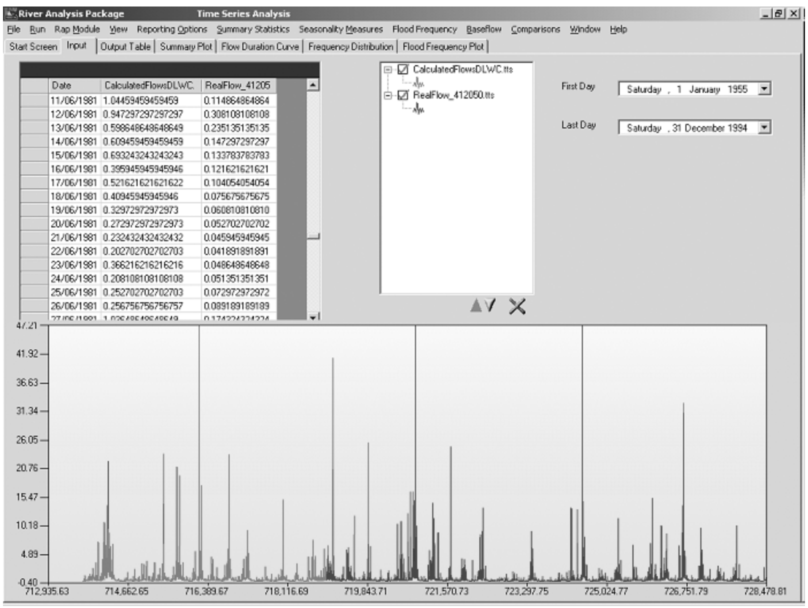

Figure 6.2 Time Series Analysis: Example of the Time Series Analysis interface showing input time series data display.

NATIONAL CONFERENCE ON INTEGRATED CATCHMENT MANAGEMENT (ICaM - 2003)

26-27 November 2003 Parramatta, NSW

ICaM - 2003 aims to bring together practising scientists, engineers, policy makers, community educators and academics in the field of environment and catchment management.

Case studies from around Australia are especially encouraged, providing delegates with opportunity to share their problems and solutions with the wider water resource community.

For further information about contributing papers or attending please email your query to icam2003@awa.asn.au

PROGRAM 7

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect May 2003

At a glance - a summary of this article

This article is a quick progress report on the design, development and construction of the Toolkit web site - the vehicle for delivering the CRC's Catchment Modelling Toolkit.

Achieving our Mission

As the CRC's researchers beaver away on the complexities of researching and integrating knowledge of catchment systems, Communication and Adoption Program staff have also been busy. The CRC points to the Catchment Modelling Toolkit as the way we will achieve our mission (if you need a refresher on the CRC's mission its on the back cover of this *Catchword*). As you might expect, I believe that delivering the Toolkit is just as important as creating it. There shouldn't be too many arguments about that one!

As Geoff Podger pointed out recently in a *Catchword* article, the Toolkit web site will be the 'public face' of the Catchment Modelling Toolkit. It will provide access to Toolkit products (once you're a registered user), technical information about those products, support for those products and news, events and publication relevant to each product of the Toolkit in general.

Changes in our team

As reported last month, we lost the talents of our esteemed web developer, Daniel Figucio. Daniel has been the force behind a number of web sites supported by the CRC including the CRC, Australian Stream Management Conference and CRC Bushfire web sites. In the short time before Daniel left he worked long, long hours to ensure that the Toolkit web site development schedule was not compromised by his departure. I am particularly grateful for his commitment to the CRC and happy to report that the engine room of the Toolkit web site is in good shape. Harold Hotham at CSIRO Land and Water has accepted the challenge of CRC web developer in the coming months (thanks Harold).

We are also very lucky to have the skills of Susan Daly, our recently appointed graphic designer. Susan is charged with the task of creating the user interface that will allow Toolkit users to obtain what they need easily.

User needs

Above all else, the Toolkit web site must serve user needs well through an intuitively-based structure. A lot of thought is required to establish a preliminary site that can be trialled by potential users.

To be successful the Toolkit web site must do a number of things well. It must:

- Assist users as much as possible to learn about, decide on and then select the product that best suits their needs
- Provide information about the technical aspects of the product's use
- Support the user in operating the product

I expect there will be many iterations in the Toolkit web site's development over the next three years, but the upcoming launch of the new Toolkit site must establish credibility with users from the outset.

Assisting users

We are currently investigating the best way to arrange the products on the Toolkit web site. After speaking to a number of industry users, there is general agreement that Toolkit products should be categorised in terms of the management issue that the product will address. Underpinning these opinions is a need for the final web site structure to allow a user to quickly and easily find a product or group of products that meets their needs.

To meet this objective each product delivered through the Toolkit web site will have its own product 'home page'. This means that users unfamiliar with a product will be able to quickly glean its characteristics, use and complexity. When a registered user selects a product to use they will be able to download it from the web site.

Technical aspects

As well as general information about specific products on the Toolkit web site, the product home page will feature a range of more technically oriented information to assist the potential user to select an appropriate product. This information will include system specifications, input requirements, output characteristics, caution notes and development history.

User support

A particular challenge is supporting Toolkit product users. In addition to the CRC's range of communications and training activities, the Toolkit website will offer a range of technical and support publications, tutorials and case studies/worked examples to assist users.

We also plan to facilitate the building of a community of users around each product through an e-group. In this forum users will be able to seek support from other users or search earlier e-group emails by topic or keyword. Naturally there will also be contact details for the specific Toolkit product's 'manager'. A news and events section on the web site for each product is also planned where users can seek information updates or learn about training and other workshops.

Conclusion

Creating all of the functionality in a web site is a significant task and once we have a working prototype (hopefully not long after you read this article) we will invite industry users to trial it and provide some constructive feedback. In the meantime the planning and construction continues.

Please feel free to contact me about any aspect of the Toolkit web site and its development.

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POSTGRADUATES AND THEIR PROJECTS

Nick Potter

I am studying for my PhD at The University of Melbourne, although I live in Canberra and I'm based at the Canberra node of the CRC. Firstly, I'll get the qualifications side of things over and done with: during my years at ANU, I completed a Bachelor of Science with honours in mathematics in 1999, and also a Bachelor of Economics in 2000.

After completing my degrees, and especially my honours year, I decided that I definitely did not want to do any more postgraduate study and thought about what I might do instead. I did a stint in the public service for a while, and then travelled to Mexico and Peru with my partner for three months at the beginning of 2001. I came back to Australia, with too many photos, and way too much debt on the credit card, and I got a three-month contract writing computer programs, and then started looking around for a job. I answered a job in the paper offering PhD scholarships at some place called the 'CRC for Catchment Hydrology'. I knew what a CRC was, and had a pretty good understanding of what a 'catchment' is, but I must confess to being pretty hazy as to what 'hydrology' meant, coming from a mathematical and statistical background rather than an environmental science or engineering one.

Nevertheless, I was accepted for a scholarship by Lu Zhang and commenced my PhD research at CSIRO Land and Water, Canberra in February 2002, with Tom McMahon at the University of Melbourne and Tony Jakeman from ANU as my co-supervisors. Although I had decided against doing further research in the past, I fondly recalled my previous research experiences as being the most stimulating periods of my life... especially in comparison with being in the public service. We decided on the title 'Statistical-dynamical modelling of catchment water balance' for my PhD, which is subject to variation at any time, but has served as a useful working title for my research.

A couple of months before getting involved with the CRC, I had moved into a new house with a large area for gardening in the back yard. My partner and I began to plant many things - mostly vegetables - during the spring. During the time that I was learning about hydrology, I was also able to watch some of the processes that we discuss in the CRC, like rainfall, irrigation, infiltration, evaporation, transpiration and so on, in my back-yard which was fascinating and helped to provide motivation for all the books and papers I had to read.

My work so far has concentrated on estimating mean-annual evapotranspiration at catchment scale, by using a stochastic rainfall model linked to a 'bucket' model representing the soil-moisture dynamics of the catchment. There is a variety of models of this type that have recently been described in the literature, and I have studied the differences, similarities, benefits and drawbacks to the different modelling formulation. I used a variation of one of the models - a model developed by P.C.D. Milly from the US Geological Survey that assumes that the rainfall and evapotranspiration parameters vary seasonally - to examine the effects of seasonality on the mean-annual evapotranspiration ratio in Australian catchments. The recent article "Winter and summer - Australian catchments behave differently to those measured overseas" *Catchword*, March 2003 pp. 4-5 describes the results obtained from this work, and I also had the opportunity to present this work at the recent EGS/AGU/EUG joint assembly in Nice, France.

The benefit of using the stochastic 'bucket' model approach to modelling mean-annual catchment-scale evapotranspiration is its simplicity. In particular, for the simple cases, analytical solutions for the soil-moisture probability distribution, and hence the expected mean-annual evapotranspiration ratio can be derived. Everyone seems to have good ideas about how to make this modelling approach more realistic by adding more process descriptions, and so more parameters, and more complexity. Unfortunately, the addition of more complexity results in the loss of analytical solutions.

One thing that came out of the application of Milly's model to the data for our Australian catchments, was the ability to partition mean-annual runoff into different sources. This led to the concept that runoff is produced from the oversupply, and variability, of water over energy in a catchment at a number of different time-scales: from the duration of a storm-front, through to seasonal, annual and inter-annual time-scales.

Rather than complicate a relatively simple model with many different extra process and spatial and temporal heterogeneity - there are plenty of catchment models that incorporate spatial rainfall, soil and vegetation data and physical flow equations - I am interested in examining the relationships between rainfall and runoff at different time-scales, and the different effects the oversupply and variability of water over energy at different time-scales has on the water balance of a catchment.

I have found the CRC a wonderful place to conduct research, primarily due to the number and variety of interesting and knowledgeable people whom I have met, and had the opportunity to share ideas with, throughout the CRC.

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OTHER OUTLETS FOR CRC PUBLICATIONS

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

AWA Bookshop (virtual)
contact Diane Wiesner
Bookshop Manager
tel: 02 9413 1288
fax: 02 9413 1047
email: bookshop@awa.asn.au
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Fax: 03 9637 8150
www.nre.vic.gov.au
Open: 8.30-5.30, Monday to Friday

CRC PROFILE

Our CRC Profile for May is:

Evan Christen

Firstly, I am very excited to be involved with the CRC again after a flirtation some years ago being involved in the evaporation basins project. That project was very successful producing a number of useful reports that are being used around the country; for irrigation related disposal in the Riverine Plain, by those involved in dryland salinity in WA and disposal of mining wastewater in Queensland (see http://www.catchment.crc.org.au/oldresearch/salinitydisposalbasins/index.html for the list of downloadable reports). Returning now to the CRC for Catchment Hydrology, I hope that the current project Project 2A: 'Reducing the impacts of irrigation and drainage on river water salinity' will be as successful as the previous involvement.

A bit about my life history. I was born in Kenya in the highlands tea growing area to a Swiss father and Welsh mother. We later moved to Zambia, from where I was sent to boarding school in Cornwall (the southwest tip of England, very wet ~ 1100mm). This meant a rather strange mix of African, European and British culture had permeated my being. However, eleven years in Australia has sorted most of that out. Australia is the best place I have ever experienced and I would think it would be hard to find a better environment to bring up a family. All three of our kids are little Aussies, and my wife Nicola loves it too. Living in the paradise of a small horticultural farm (grapes and oranges) in Griffith who wouldn't?

My interest in agriculture I believe stemmed from the tea growing in Kenya, a truly impressive sight with beautifully manicured tea trees covering the hillsides. So after school I studied agricultural engineering (engineering at the insistence of my father who holds three engineering degrees). That was when I first came into contact with irrigation (though not on a grand scale in the UK), and always having been attracted to playing with water I thought that it was something I want to get into. A brief interlude with commercial irrigation design and sales in the UK made me realise I had to get out into the real world of irrigation (semi-arid climates!, although the rainfall around Cambridge averages 560mm/yr making it one of the driest spots in western Europe). So I undertook a Masters degree in soil and water engineering at Cranfield University, better known as Silsoe college.

After that I was unsuccessful in begging a job from the international consulting firms (except an offer of unpaid work in a rubber plantation in Indonesia) but was offered a PhD position to undertake research into mole drainage with CSIRO Land and Water in Griffith.

This sparked off my career in drainage. The mole drainage never really took off in irrigated areas although it is used extensively in south western Victoria for rainfed dairying. There followed a Post doc position at Griffith, looking at better management of the extensive areas of 'tile' drained orchards in the area. (They were called tile drains, as originally clay roof tiles were adapted to form the drainage pipes). This was followed by projects looking at the design, siting and management of evaporation basins and conjunctive use of groundwater and surface supplies for irrigation (involving research in Pakistan too). This all led to a project to review drainage practices in Australia which culminated in a set of Best Management Practices for reducing drainage volumes and salt loads (http://www.clw.csiro.au/publications/technical2001/tr38-01.pdf) These have created a lot of interest in Australia and internationally. Now I am getting involved in an interesting new area of using wastewaters and other low quality waters for irrigation.

To finish, I look forward to building good relationships with the others working on irrigation in the CRC and taking the opportunity to broaden my horizons in hydrology generally. Also I would like to invite anyone to drop in on me at the Griffith Laboratory, for a tour of the Murrumbidgee Irrigation area, sampling at some wineries and a tour of our piece of paradise.

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WHERE ARE THEY NOW?

Report by Murray Peel

Since my last "Where are they now" contribution (*Catchword*, 87, September 2000) I have not moved at all. I am still located in the same office of Civil & Environmental Engineering at the University of Melbourne and am working as a Research Fellow. During this period I have demonstrated low spatial variability and thus have few exotic stories of life in other locations. However, this spatial limitation does not restrict the modern desktop hydrologist from pursuing a wide and diverse range of interests.

My PhD thesis "Annual runoff variability in a global context" (Project A4 in the first CRC for Catchment Hydrology) was passed in early 1999. The main conclusions from my thesis were that the variability of annual runoff in temperate Australian and Southern African rivers is generally higher than that for rivers from other continents in a temperate climate zone, confirming and refining the earlier work by McMahon *et al*. The primary causes of the variability differences were suggested to be the distribution of evergreen and deciduous vegetation, in association with the spatial distribution of mean annual precipitation. Temperate forests in the Southern Hemisphere are predominately evergreen, while those in the Northern Hemisphere are predominately deciduous.

Since the PhD I have continued to investigate various aspects of global hydrology. Published papers include a discussion of the implications of the relationship between catchment vegetation type and the variability of annual runoff for water resources management, stream ecology and fluvial geomorphology. A second paper contained a global analysis of the variability of annual precipitation and its relationship to the El Niño-Southern Oscillation. This paper showed that stations influenced by ENSO have variability of annual precipitation in the order of 5%-25% higher than stations not influenced by ENSO. Recent collaboration with Professors Geoff Pegram and Tom McMahon investigating continental differences in wet and dry periods of annual rainfall and runoff has led to one paper being submitted and several more in preparation.

I have also been involved in two Macaque applications to predict the impact of vegetation (mainly ash-type forest) disturbance on water yield. These applications were in the Thomson, Maroondah (Victoria) and North Esk (Tasmania) catchments. The recently completed Macaque application in the North Esk catchment revealed that the likely impact on summer low flows of several logging and tree farming scenarios was strongly limited by the topography of the catchment. Areas covered by candidate species for logging or tree farming only contributed about 33% of summer low flows prior to disturbance. Significant summer low flow contributions were sourced from vegetation types in higher elevations that are less suitable for logging and remained undisturbed in the modelled scenarios. The 33% of summer low flows from the disturbed areas were highly impacted in the modelled scenarios, but the overall catchment impact was limited by the 67% of summer low flows from the non-disturbed areas.

I was also involved in a project for the National Land and Water Resources Audit, where streamflow records from 331 stations around Australia were modelled using SIMHYD in order to extend the flow records at those stations.

My PhD thesis and some reports are available for download (all in pdf format) at www.civag.unimelb.edu.au /~mpeel/publications.html References to journal and conference articles are also available from my web page.

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