NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

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A NOTE FROM THE DIRECTOR

Professor Russell Mein

Inside...

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

COMPLETING THE CRC'S MISSION: DEVELOPMENT OF OUR NEXT ROUND OF PROJECTS

The initial round of core projects for the CRC has about a year to run, but already we have started a process to identify and work up projects to commence in 2003. Our past experience has shown us the benefits of detailed planning, and the time it takes to develop projects which meet user needs, bring different disciplines together, take advantage of the capabilities of our Parties, include strategies for adoption, and have the best chance of success.

Relevance of Business Plan

The Business Plan for the CRC was developed as part of our bid for a second term of funding under the Commonwealth Program. The extensive planning and consultation needed to develop that document was certainly worthwhile; our Business Plan has been the guiding light for the activities of the Centre.

However, the world is changing, and changing fast. A plan written in 1998 needs review to see if it is still on target to best meet user needs.

Our process to develop the next round of projects started with a Future Issues Workshop in May 2001. At this workshop, leaders from a variety of industry and research organisations outside the CRC were asked to identify and set priorities for the top land and water management issues. Generally speaking, the objectives of the CRC specified in the Business Plan were pretty much on target to meet these needs.

The second step in the process was to ask our own CRC Parties about the issues as they now see them. A strategic planning session at the November 2001 Board Meeting brought forth a list of areas that they wanted addressed in the next round of projects. This list was again largely consistent with the CRC's Business Plan objectives.

Assessing where we will get to by the end of 2002

Our third step involved our Program Leaders and Focus Catchment Coordinators in a three-day workshop held at Woodend last month. They were asked to forecast the capability we would have after completion of the first round of CRC projects, ie by December 2002. This was done program by program, with some effort being made to look across program areas to our projected integrated capability.

Catchword readers will get more information about this capability in a forthcoming issue, but it is fair to say that we were all pretty impressed at the progress that we expect to have made by year's end.

Filling the 'gaps'

A comparison of the capability we will have, after this project round, with that needed to meet Party (and Business Plan) expectations was made to identify the activities we need to undertake in the next round. Our Woodend group has documented some 50 activities to 'fill the gap'; these range from 'straight' research, through development of (software) tools, to communication and adoption requirements. Given the intention that the prime performance indicator for the CRC is adoption of our 'products', the latter activities rank highly in what needs to be done to achieve this.

Next Steps

The Board will review our 'capability and gap' analysis at their February 2002 meeting, before we proceed to the next step. This involves holding a number of Technical Advisory Group (TAG) meetings for likely program areas, at which researchers, from inside and outside the CRC, will consider projects which combine the activities needed to complete our mission.

Collaborative opportunities with related CRCs, and other research groups, will be a prime focus of the TAG process; it is essential that we involve the right people, right from the start.

Project abstracts are envisaged for preliminary examination/approval at the May 2002 Board, with full Project Agreements being the CRCs target for the August and November Meetings this year. The aim is to have staff appointed and ready to go when we start the second round of core projects a year from now.

As I said at the beginning, the process is a lengthy one; it is also inclusive. If you feel it would be of mutual benefit to be involved in the CRC's next round of projects, now is the best time to make contact. Give us a call.

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

Report by Rob Vertessy

As we enter our third and final year of the first round of projects in this CRC, activity in all of the Programs is hotting up. This is going to be a VERY busy year for the Predicting Catchment Behaviour Program, with some exciting new developments about to emerge. In this issue, I'd like to focus on some of the software being developed in the Catchment Modelling Toolkit Project (1.1). In 2002, the Toolkit project is targeted on enhancing and test-bedding our two model development frameworks ICMS (now termed 'Interactive Component Modelling System') and Tarsier. Both frameworks (particularly Tarsier) need further development before they can satisfy all of our needs associated with the development of a Modelling Toolkit.

Training and more training!

Part of the test-bedding process entails training modellers in the use of these frameworks. Even though both our frameworks are still developmental, we believe that they will only grow properly if modellers start using them now and evaluate their deficiencies and strengths. So, there will be several workshops and one-on-one training sessions held through the year, keeping the Toolkit team pretty busy. In fact, as I write, Susan Cuddy is down the corridor from my office running a two-day workshop on ICMS. Even closer, in the next door office, Shane Seaton and Joel Rahman are preparing model developer's documentation for Tarsier, to complement a training workshop they will be running on that framework in early March. By the end of the year, we should have at least 30 modellers trained in the use of the frameworks, giving us invaluable feedback on how to improve ICMS and Tarsier.

Model implementation

Another dimension to the test-bedding process is the implementation of various models within the two frameworks. Last year we successfully implemented the Environmental Management Support System (EMSS) in Tarsier. This was a very ambitious job but well worth the effort as it demonstrated that we could deploy a dynamic (daily timestep) model operating over a large (23,000 km^2) spatial domain, with high-level user interface and visualisation features. Another thing that we demonstrated was that by writing this system in Tarsier and employing modern software engineering practices, we can re-use some of the code in other applications. We are doing just that in a new model under development code named Terrapene.

Terrapene

Toolkit software engineers Shane Seaton and Joel Rahman are working with Mat Gilfedder and Mirko Stauffacher to develop an innovative catchment salt loads model. Under the auspices of the MDBC-funded Catchment Categorisation Project led by Glen Walker, Mat and Mirko have developed a model that can predict the speed and magnitude of catchment yield and salt load response to land cover change. They knocked up their early ideas in a reasonably sophisticated Excel spreadsheet but wanted their model deployed as a high-quality software product to increase its power and usability. We saw the opportunity to build upon the interface we had developed for the EMSS so set about the task of retrofitting this to their needs.The result after a month of work is a pretty snappy prototype model that is sufficiently advanced to take to clients and co-developers for their reactions. A long-term benefit is that any user of the EMSS (used for runoff, sediment and nutrient load prediction) would quickly grasp the user interface for Terrapene, and vice-versa.

Local Scale EMSS

The Toolkit team is working with the Moreton Bay Catchment and Waterways Partnership, Pine Rivers Shire and The South East Queensland Water Corporation to build a local-scale version of the EMSS to operate of the catchments of Lake Samsonvale and Lake Kurwongbah (about 500 km^2). Unlike the regional EMSS developed for the whole SEQ region, the LEMSS will have a fairly fine spatial grain (elements of a few 100 m^2, rather than tens of km^2) and deal with the water, sediment and nutrient balance of the landscape in a more process-based manner. Fred Watson, the lead modeller on this project, is developing a suite of new modelling tools in Tarsier to underpin this model. One of the more exciting developments so far is an innovative technique to agglomerate raster or 'grid' cells with common properties, thus leading to an efficient spatial structure for hydrologic modelling. Fred has also devised a technique to model the whole spectrum of flow in a catchment (from diffuse flow over hillslopes to concentrated flow in channels) using a single node-link routing scheme. We will provide further details on these methods in future editions of *Catchword*.

Stochastic data generation models

Over the last two months, Program 5 (Climate Variability) researchers Tom McMahon and Sri Srikanthan have been briefing the Toolkit team on a range of stochastic data generation models that they have been using, and will be developing in the future.

We will soon start deploying some of these models in one of our modelling frameworks, thereby integrating them into the Modelling Toolkit proper.

TIME – The Invisible Modelling Environment

On a much more strategic research front, Joel Rahman has initiated development of a new modelling framework code-named TIME (an acronym for The Invisible Modelling Environment). This is founded on Microsoft's new .NET technology and deployed in their Visual Studio programming environment. A crucial element of this capability is that it permits models written in different languages to be linked together in the one framework, and simplifies the task of writing within a framework. Neither ICMS nor Tarsier permit the linking of models written in different languages, though stakeholders insist that such a capability is important.

TIME is very much in an embryonic phase now, but some exciting new capability is beginning to emerge. At this stage we regard this development work as pure research and are therefore not depending on it to succeed. However, it's the kind of innovation that we need if we don't want to be left behind in a few years time as the software industry moves on.

Once again, we'll keep you posted on this work in future issues of *Catchword*. If you can't wait, contact Joel on: joel.rahman@csiro.au.

Finally, best wishes to you all for 2002. Please keep visiting our Toolkit web site at www.catchment.crc.org.au/toolkit to see how we are progressing.

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PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Peter Hairsine and Tim Ellis

Predicting sediment and nutrient delivery in cropping lands

The major aim of Project 2.2 ('Managing pollutant delivery in dryland upland catchments') is to enable the prediction of pollutants from cropping land as impacted by management practices. In this article we report on a tool that has been developed to address this aim for cropping areas of moderate to high topography.

For the past fifty years unacceptable levels of soil erosion in upland cropping environments have led to the development and refinement of soil conservation practices. Our upland farming landscapes have many contour banks, filter strips and grassed waterways that have been engineered to reduce soil erosion. These measures when combined with appropriate surface management practices have several benefits including:

- Reduced sheet and rill erosion from hillslopes
- Greatly reduced incidence of gully formation during intense rainfall and runoff
- Slowing of runoff and resulting lessening of local flow peaks
- Reduced sediment and attached pollutant delivery to stream networks

The design of contour banks and grassed waterways has primarily focused on the first two of these benefits, though there are clearly benefits for the latter two issues.

Tim Ellis and colleagues in Project 2.2 have recently developed a computer model to permit the assessment of the impact of soil conservation measures on sediment and nutrient delivery to streams. The program is written within the ICMS framework (one of the preferred modeling frameworks within the CRC for Catchment Hydrology's modelling toolkit) and has the following features:

1. A graphical user interface for the linking of hillslope, contour channel and waterway objects.
2. Use of the multi-size class sediment sorting routines developed by the project. This feature enables prediction of the consequences of size selective deposition of sediment for attached nutrient delivery.
3. Contour channel design to optimise erosion protection and sediment trapping.

NEW TECHNICAL REPORT

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

by

Francis Chiew
Phillip 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.

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

Note that the program is currently available as a research tool only though there are plans to make it more user-friendly and available. This process requires input from parties with expertise in farm planning. Guy Geeves, NSW DLWC and Chris Carroll, QDNRM, are assisting in this aspect of the tool development.

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PROGRAM 3
SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Sergei Schreider and Chris Schilling

Project 3.1 "Integration of Water Balance, Climatic and Economic Models": Economic Model Quest

Background

While the decision on which climatic and hydrologic models are to be incorporated in the integration framework for Project 3.1 has been finalised (see *Catchword* No 100), the choice of a socio-economic model is still undecided. The selection of the biophysical models was not difficult because the stakeholders' preferences and modelling developments in other CRC for Catchment Hydrology Programs pre-defined this choice. Selecting socio-economic modelling tools however is a much more challenging task.

Socio-economic model capabilities

The major requirement of the socio-economic model is that it meets the water allocation planning needs of the project stakeholders. Hence in selecting an economic model we are using a stakeholder participatory approach. A number of meetings with stakeholders (DLWC, G-MW and DNRE) have been organised to formulate the major requirements for the socio-economic modelling tool. Further meetings are being scheduled. This tool will be needed to support stakeholder decisions on water allocation planning. Stakeholder participation will be maintained over the life of the project, and researchers will be able to adjust the model to meet user requirements at each stage of the integrated modelling system development.

Model options

Two options are being considered:

- use of one of the existing models approved by our stakeholders, or
- development of a new modelling tool.

Modification of existing modelling tools to meet the demands for Project 3.1 may also be considered. It is important to comprehensively understand which of the existing economic models might be suitable candidates for adoption.

Some broad requirements of the economic models for use in Project 3.1 can be formulated. Firstly, these models should be used as decision support tools for the project stakeholders (catchment water authorities). This means that the models have to represent the socio-economic processes at the entire catchment scale. The farm based models can also be included in the integration framework, but as secondary models (e.g. models for simulating farmer behaviour) leading to the estimation of possible water demands in irrigated areas.

Water trading reform

These socio-economic models must be free-market based models taking into account the processes initiated by the COAG water trading reform. However, the specific conditions and constraints of the water market make it significantly different from the market regulating trade of other agricultural resources and products. A number of geographical constraints on water trading exist (e.g., trading of water from downstream to upstream areas). Some socially based administrative constraints are also introduced by local authorities, such as a restriction within the Goulburn system that permanent trade out of an irrigation area must be less than 2% of total irrigation area diversions.

Economic modelling in 'Integrated Assessment': what's available on the market?

- MODSIM Congress

Modelling for integrated catchment assessment is an actively developing area and our project team shares this space with many other research groups. Given resource constraints, it is important that we avoid replication in the work we implement. The International Congress on Modelling and Simulation MODSIM01 held in Canberra (10-13 December 2001) provided a unique opportunity for us to learn more about modelling integration being developed by other research groups. This biannual congress, organised by the Modelling and Simulation Society of Australia and New Zealand (MSSANZ), attracted about 400 participants from Australia and overseas working in the area of modelling in different scientific disciplines. The theme of modelling integration for resource management in predominantly agricultural catchments was presented in four Sessions: "Decision Support Frameworks", "Agricultural System", "Agent based modelling" and "Integrated Catchment Management". The MSSANZ President Prof. Tony Jakeman in his keynote paper[1] formulated the general features and role for models in integrated catchment assessment and management.

A comprehensive review of all the integrated modelling systems presented in MODSIM01 is outside the scope of this article but those approaches with aims close to those of Project 3.1 are mentioned below.

- ICMS modelling in the Namoi Basin

A paper based on use of the Integrated Catchment Management System (ICMS) was presented by Rebecca Letcher from the Integrated Catchment Assessment and Management (ICAM) Centre at the ANU. The integrated system presented in her paper aims to investigate the trade-offs between different policies for off-allocation water in the Namoi River catchment. The catchment is mapped into sixteen relatively homogeneous regions in terms of important economic and social scales for water allocation. Thus the regions are chosen to be relatively similar in terms of ground and surface water policy, and farm production type. Each region is modelled as though controlled by a single farmer whose sole objective is to maximise profit. Optimisation variables over the long run include:

- Irrigated area
- On-farm storage capacity
- Irrigation efficiency

The model simulates six different options. Each option has two choices: firstly, transfer or no transfer of off-allocation water to groundwater users, and secondly, the extent of activation of sleeper licenses: full activation, half activation, and no activation. These options are fed through the model via the water availability constraints at the farm decision making level. The economic optimisation is implemented using a dynamic programming algorithm.

This modelling could be employed within Project 3.1 for on-farm modelling in the focus catchments. The principal difference in our approaches is that Project 3.1 deals with allocated water, whereas the Namoi model is focused on off-allocated water resource management, mostly in unregulated sub-catchments.

- The IWRAM Project

In the keynote paper Tony Jakeman presented the integrated modelling framework developed for sustainable water resource management in small highland catchments in Northern Thailand. A major challenge and feature of the Integrated Water Resource Assessment and Management (IWRAM) project was to develop a modelling framework that integrated the relevant biophysical, economic and socio-cultural components operating in the catchments.

Reflecting this multi-disciplinary framework, a decision support system was designed so as to provide stakeholders with a tool which, in addition to modelling hydrological processes, incorporated local socio-cultural and economic realities.

The biophysical component included the modelling of surface hydrology, soil erosion and crop yield in relation to climatic forcing and land use in the catchments considered.

The economic model employed linear programming optimisation under given resource (water, land, labour, finance) availability constraints.

UPCOMING TECHNICAL REPORT

THE DEVELOPMENT OF WATER REFORM IN AUSTRALIA

by

John Tisdell
John Ward
Tony Gudzinski

Report 02/5

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

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

Advance orders welcome.

OTHER OUTLETS FOR CRC PUBLICATIONS

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

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While being an excellent example of a modelling integration system, the IWRAM project was developed for a regional and social context very different than that in Project 3.1.The major conceptual difference between these two projects is that IWRAM deals with unregulated catchments without strictly defined allocation licensing. Water trading processes are also not considered by the IWRAM economic model.

- The INSIGHT modelling system

INSIGHT, an integrated spatially explicit modelling program capable of exploring alternative policy options for land use within the Lachlan River catchment, was presented in a series of papers by Russell Gorddard (CSIRO Sustainable Ecosystems), Paul Walker, Martin Van Ittersum and David White.

INSIGHT was specifically developed to evaluate policy alternatives for land and water use. It is not intended to be used at farm level, but rather at the policy making level. It focuses on increasing insight into and understanding of the system rather than on predicting future developments.

The model covers the Lachlan Catchment, an area of approximately 84,700 km^2. The model uses 100 mapping units, defined by intersections of local government, statistical local areas and sub-catchments of the Lachlan River. The mapping units are further divided into three farm types - lifestyle, small family and agri-business - to define decision units.

INSIGHT utilises three crop models (wheat, grassland and livestock), groundwater, soil acidification and catchment scale surface water models. The water balance model links the water use of different land use options for each land unit with the rate of rise in groundwater and changes in flow level of the Lachlan River. The farmer's response depends on farmer objectives and constraints.

Surface hydrology is modelled using the IQQM system in the Project 3.1 framework. However the major methodological difference between our integration approaches and INSIGHT is that, at present, INSIGHT is developed for managing dry land agriculture in the catchment, rather than water allocation.

- SWAGMAN Futures

The SWAGMAN Futures modelling approach was presented by Shahbaz Khan from the Resource Management for Sustainable Irrigated Agriculture research group at CSIRO Land and Water. SWAGMAN aims to integrate crop, soil, water and salinity dynamics with surface/ground water interaction models and irrigation area economics.

Groundwater is the major resource considered for modelling in the Coleambally Irrigation Area in the Murrumbidgee catchment. The irrigation area is modelling by dividing it into eleven economic units, each containing a number of hydrogeologic cells. Input/Output scaling, using a weighted average function, is necessary between the differently sized units. The overall model components explicitly discussed were:

- Hydrogeological system module
- Unsaturated soil module
- Hydrologic economics integration module, based on the non-linear optimisation algorithm.

The importance of the SWAGMAN approach for Project 3.1 is that this model deals with water trading processes. However, water trading is considered only for a very limited area within the Coleambally Irrigation Area. The major difference between the SWAGMAN approach and that accepted in Project 3.1 is that in the latter, the surface water is considered as the more important resource in the catchment scale (e.g. surface water is more than 97% of total water allocated for irrigation).

- RIMIS

The Regional Integrated Management Information System (RIMIS) framework was presented by Bill Watson from the ICAM Centre at the ANU. Its modelling approach seems to be very similar to that selected in Project 3.1, however RIMIS is in the initial stage of development and cannot be considered for ready adoption.

- ABARE model

Among the models reviewed but not presented in MODSIM01 is the ABARE economic model[2]. This model was specifically developed to assess the impact of water reforms. It focuses on the Murrumbidgee Irrigation Area in NSW and the Kerang-Cohuna district in Victoria. This model aims to integrate information on the financial and biophysical factors influencing farmers' water use decisions.

The design of the framework sought to incorporate uncertainty about the availability of allocation supplies and irrigation requirements, to a greater extent than previous economic models, by developing links to account for climatic conditions and different crop decision stages during a season. The model uses four decision making groups encompassing different farm size and water use characteristics.

The modelling task is to optimise use of both groundwater (groundwater modelling is included via the

SWAGMAN Destiny model) and surface water resources, modelled by IQQM. The economic optimisation is based on a linear programming algorithm.

This model provides for decisions by farmers; this is the major methodological difference between the ABARE model approach and that adopted for Project 3.1 where the decisions are made by catchment water authorities.

Conclusions

The major conclusion from our preliminarily study of the socio-economic models available on market is that none of them are exactly suitable for the purposes of Project 3.1. The models are mainly farm-based and are not directly oriented to decision support systems used by irrigation water authorities. Nonetheless, the project can utilise where appropriate the modelling experience that has been accumulated. Particularly, these results could be included in the modelling of irrigators' behaviour. The simulation of irrigators' behaviour could then be used as an auxiliary modelling tool for water allocation planning. The main economic model, however will be designed as an indicator-based policy/scenario evaluation algorithm working at the entire catchment scale.

Surprisingly, no models developed overseas were judged suitable for the shortlist (Note 1). The possible explanation is that the regional properties of Australian rural catchments are much different from those of other continents. Another important reason why some European and American integrated systems were rejected is because they are based on very particular software platforms which are not computationally compatible with the major biophysical models used by the Australian stakeholders (i.e. IQQM, REALM). And finally, the modelling integration systems usually include some 'know-how' components left outside the published paper or the conference presentation. Consequently, an adequate impression about the system can be formed only after discussions with the authors.

Our apologies to other researchers whose modelling integration methodologies were not mentioned in this article. The selection criteria were based on the relevance of the methodologies to Project 3.1 tasks as we authors perceive them. No judgements about the quality of other integrated modelling systems are implied.

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References

[1]Proceedings: International Congress on Modelling and Simulation MODSIM01, Ghassemi, F., Cuddy, S., Little, R., Littleboy, M., McAleer, M., Nakanishi, T., Oxley, L., Post, D., Scoccimarro, M., Sivapalan, M., Vertessy, R., Whetton, P. and White, D. (volumes' eds.), Canberra, Australia, 10 - 13th December 2001, Vol. 1-4.

[2]McClintock, A., Van Hilst, R., Lim-Applegate, H., and Gooday, J. 2000, 'Structural Adjustment and irrigated broadacre agricultural in the southern Murray Darling Basin', ABARE report, Canberra.

Notes

Note 1: INSIGHT and IWRAM are joint ventures with Dutch and Thai scientists, respectively. Some modelling components of SWAGMAN were developed in MIT, USA

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

UPCOMING TECHNICAL REPORT

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

by

Francis Chiew
Phillip 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 available from early March 2002 through the Centre Office from $27.50

Advance orders welcome.

PROGRAM 4
URBAN STORMWATER QUALITY

Program Leader
TONY WONG

Report by Muthukumaran Muthukaruppan & Tony Wong

Metals in Stormwater

Introduction

A major goal of the CRC for Catchment Hydrology is to develop a decision support system to allow Australian professionals in the stormwater industry to make more informed and cost-effective decisions about various stormwater management strategies. The Model for Urban Stormwater Improvement Conceptualisation (MUSIC), developed for this system, has undergone a nine-month pilot testing stage and currently is being prepared for industry release. Concurrent with the development of this software are research activities directed at further improving its predictive capability. It is envisaged that MUSIC will be updated regularly as findings of research activities undertaken become available.

A key input into MUSIC is the characteristics of urban stormwater pollutants. This includes non-point source pollutant export rates, pollutant concentrations, pollutant speciation (relationship between various pollutants, pollutant forms and particle size distribution) and causal factors (catchment land use, climate, rainfall intensity, soil type, etc.). A number of projects are currently being undertaken to derive pollutant generation and pollutant speciation relationships from several monitored urban catchments. This article describes a current PhD project aimed at studying suspended sediments and associated metal concentrations in urban stormwater. The project is based on field monitoring of urban catchments in Melbourne and Brisbane.

Suspended Solids in Urban Stormwater

Practically all stormwater pollution studies report sediment or suspended solid loads. Suspended solids are generally considered as the primary pollutant because they act as carriers of other pollutants such as nutrients, heavy metals, toxins and other inorganic and organic materials.

Most water quality monitoring and modelling studies report on either total pollutant loads or event mean concentrations of stormwater pollutants. The design of many stormwater treatment measures can be significantly improved by more information on pollutant characteristics such as the distribution of particle size and settling velocities of suspended solids and other associated contaminants. For example, many studies have shown that contaminants in urban stormwater, such as nutrients and metals, have a higher propensity to be associated with finer particle size fractions of suspended solids. This is attributed to the higher surface area to volume ratio in fine particles and thus a greater access to ionic binding surfaces for these contaminants. Given that contaminants such as nutrients and certain metals (eg. copper) are attached to the finer fractions of suspended sediments, their effective removal will require

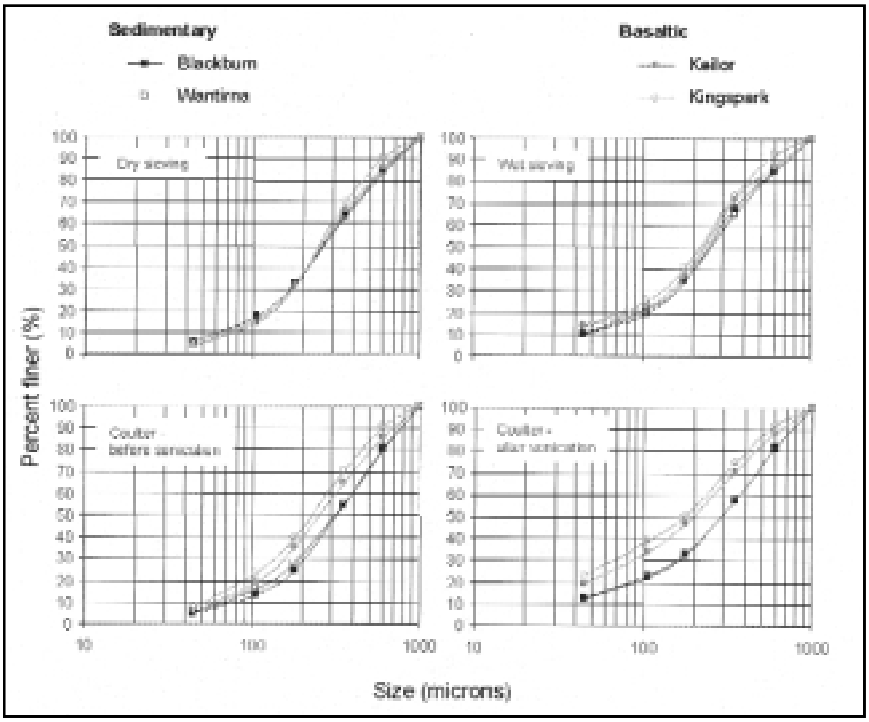

Figure 4.1 Particle size distributions of particulates sampled from road gutters

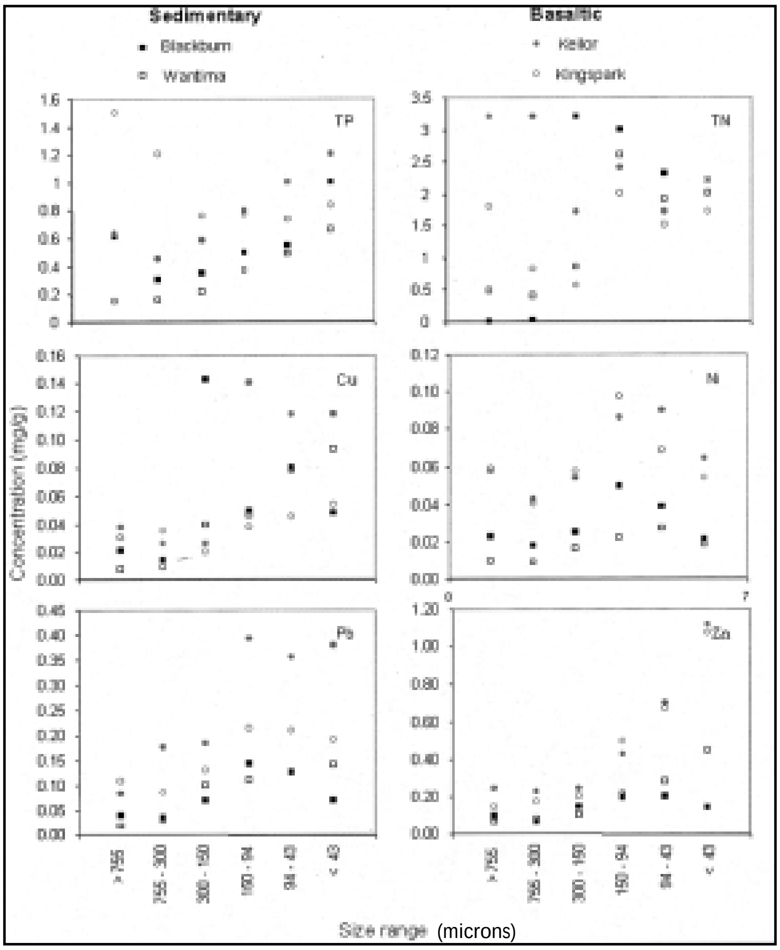

Figure 4.2 Pollutant concentrations across different particle size distributions

stormwater treatment methods such as ponds and wetlands to be designed to target these finer sediments.

Many factors can influence the distribution of urban contaminants within the particle size ranges in urban stormwater suspended solids. Particle size distribution and pollutant association may vary for different urban catchments owing to land use and geological setting. For example, it has already been established from a previous study that particle size distributions of suspended solids in waterways in the basaltic areas in western Melbourne, Australia, are finer than those found in waterways in the sedimentary areas in eastern Melbourne. It is important to establish if the different geological setting has also influenced the characteristics of other contaminants exported from urban areas.

Scoping Study

A scoping study to refine sampling and analytical procedures for defining the distribution of urban contaminants over the particle size range of deposited urban sediments was undertaken as part of a PhD study. Dry sediments deposited on road surfaces and gutters in several parts of Melbourne were sampled and analysed. These were characterised according to their particle size distribution and particle density, organic content, nutrient and heavy metal concentrations over four particle size ranges. Multiple samples of dry sediments were collected from four urban sites using a battery powered, hand held portable vacuum cleaner, which has been shown to be effective in collecting sediments below 1000 µm. Samples were collected from three road surface locations (each over a 2 m^2 area) and three gutter locations (each over 10 m length). The three samples were then mixed to provide a representative samples of road surface and road gutter sediments for the site. The samples were then sieved through a 1000 µm sieve, and the sieved samples used for further analyses. Although limited to two sample sets, the analysis suggests that the two catchments on basaltic soils have higher sediment loads compared with the sedimentary catchments.

Particle Size Distributions

Four methods were used to determine the particle size distribution (PSD) of the dry sediments sampled. The first was a dry sieving method where the dry sediments were sieved through a stack of sieves with aperture sizes of 600, 355, 180, 106 and 45 µm in a sieve shaker for 20 minutes. The second was a wet sieving method where the sediments were soaked in water and left for

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.

Please note that conference attendees will be sent a complimentary copy

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NEW WORKING DOCUMENT

MODELLING VICTORIAN ANNUAL RAINFALL DATA

by

Ratnasingham Srikanthan
Tom McMahon
Mark Thyer
George Kuczera

Working Document 01/1

Annual rainfall data from twenty stations with long records were analysed with regard to wet and dry spells and long-term persistence. Small changes in the means and standard deviations over time were observed from the time series plots of the data.

The Hidden State Markov (HSM) model was fitted to the data and the results indicated the absence of two state persistence in the data. One hundred replicates of annual rainfall data were generated using the HSM and the widely used first order autoregressive model. The autoregressive model preserved the moments of the data better than the HSM model as these were directly input to the model. The low rainfall sums were satisfactorily reproduced by both models.

A further study is in progress using a number of stations selected across Australia and carrying out the HSM calibration with different starting months.

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one hour. The sample was then passed through the same stack of sieves. The material retained in each sieve was then oven dried and weighed to obtain the PSD. In the third and fourth methods, the PSD was determined using a fluid module Coulter LS 130 counter. The Coulter counter uses laser light at 750 nm to size particles from 0.4 µm to 1000µm. The Coulter counter has a built-in sonicator which uses ultrasound waves to further disperse the sediments in solution. The PSD was determined with and without sonication to compare the effect of sonication on the PSD.

Figure 4.1 shows the resulting PSD for two lots of samples taken on 15 May and 15 September 2001. The PSD from the dry sieving analyses were found to be similar in the four catchments, with about five percent of the particles smaller than 45 µm and the median particle size is approximately (D50) 250µm. However, the wet sieving and Coulter counter analyses showed that the sediments from the basaltic catchments appeared to be finer than the sediments from the sedimentary catchments. This difference is more apparent in the results from the Coulter counter after sonication.

Pollutant Concentrations

The pollutant concentrations in the various particle size ranges are presented in *Figure 4.2*. TP, Ni, Pb and Zn concentrations were found to be higher in the basaltic catchments compared to the sedimentary catchments. This may be attributed to the basaltic geology being rich in Zn and Ni content. *Figure 4.2* also shows that the metal concentration in the basaltic catchments increases as the particle size decrease, while this trend is less obvious in the sedimentary catchments.

Conclusions

Although limited to two sample sets, the analysis suggests that the two catchments on basaltic soils have higher sediment loads and finer sediments compared with the two catchments on sedimentary soils. The trace metal concentrations associated with the finer sediments in the basaltic catchments were also found to be higher than the concentrations associated with the coarser sediments distribution found in the sedimentary catchments. These results suggest that stormwater treatment facilities may have to be designed to operate at lower hydraulic loadings in the basaltic regions in Melbourne compared to the sedimentary regions.

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PROGRAM 5
CLIMATE VARIABILITY

Program Leader
TOM McMAHON

Report by Harald Richter and Graham Mills

Soil moisture in weather forecast models

In essence, a weather forecast model is a piece of computer code that integrates an initial set of values for wind speed and direction, temperature, humidity, and pressure on a regular three-dimensional grid, and moves it forward in time. This period of integration can range from a few hours for a high-resolution mesoscale model through several days for a global medium-range model, to centuries for a climate model. Particularly for the weather forecast models, the specification of a fairly accurate ``initial state'' is crucial to the accuarcy of the forecast, as errors in any of the model fields at the initial time will feed through the forecast, and increasingly affect all other model fields throughout the integration period.

Specifying initial atmospheric conditions

The specification of the initial state of the atmosphere requires observations of a number of independent meteorological fields such as wind, temperature and humidity. A network of surface observation sites around Australia allows the derivation of initial wind, temperature or humidity fields on the surface. A sparser network of upper-air sites launching balloon-borne radiosondes allows the same derivations for the Earth's atmosphere up to about 15 km altitude. Remote sensing instruments contribute additional information about the initial fields in the atmosphere and along the ground. These diverse data are used to specify the initial gridded model fields in a process termed ``data assimilation.'' During this process, a series of short-term (typically 3-6 hours) model forecasts are corrected using the discrepancies between the actual observations and the model forecasts, so that the series of short-term forecasts always incorporate the information from the latest observations.

Soil moisture influence

Soil moisture has a profound influence on the latent and sensible heat fluxes between the ground and the lowest layers of the atmosphere. These fluxes then contribute to the temperature and humidity structure of the atmospheric boundary layer and thus ultimately influence rainfall and other meteorological forecasts. So, how can one set the initial states for or 'initialise' a soil moisture field that has no routine observations to draw from?

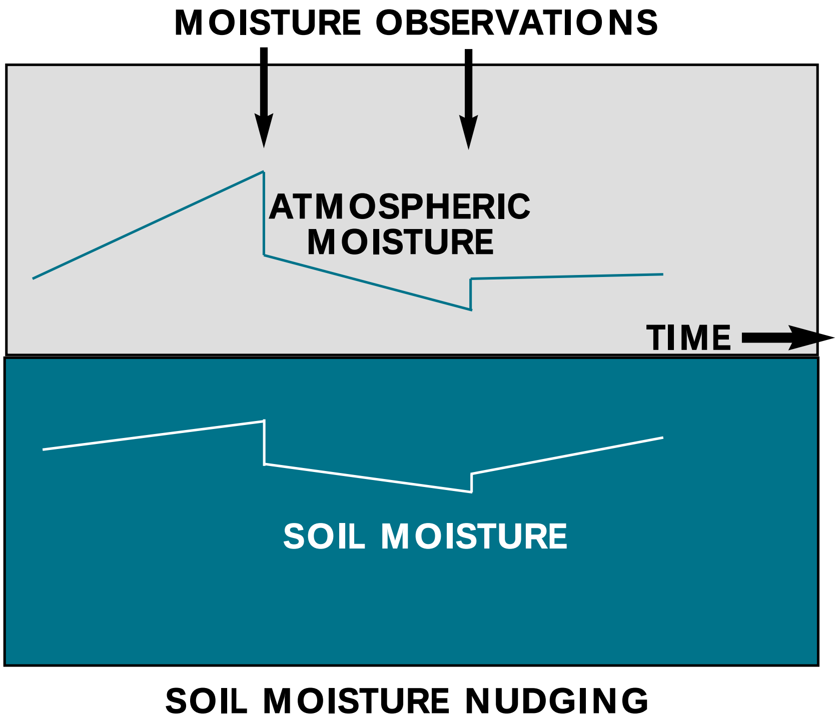

Figure 5.1: Qualitative time evolution of the Meso-LAPS screen-level specific humidity and root zone soil moisture.

This article outlines some of the specifics on how soil moisture is initialised in the Bureau of Meteorology's Mesoscale Limited Area Prediction System (Meso-LAPS).

Operational forecast models

Meso-LAPS is one of the operational forecast models for the Australian region. Fields are specified on 600 x 480 grid points horizontally (i.e. every 12.5 km x 12.5 km), and on 29 vertical levels. The computational domain extends well beyond the Australian continent, from 55 degrees South to some 5 degrees North, and 95 degrees East to about 170 degrees East. Vertically, the domain extends from 289 cm below the surface, up to approximately 20 kilometres above the ground. Most model fields are updated every 10 seconds during the integration process. The soil moisture field in the model is integrated within the land surface scheme of Viterbo and Beljaars (1995) and is updated every 4 minutes.

Inferring soil moisture content

Given the absence of direct observations for the soil moisture initialisation, a related field, the screen-level (some 1-2 m above ground level) specific humidity, is used to infer the soil moisture content in the root zone layer (the top metre of soil). This inference-based technique is known as ``soil moisture nudging,'' in which a model-based first-guess soil moisture field is nudged towards a more realistic value (Viterbo 1996). The underlying assumption is that errors in the short-term model forecast (or first-guess) of screen-level humidity are due to two factors: advection errors, and errors in the parameterised evaporation.

A correction to the model soil-moisture should lead to a reduction in the model error due to mis-represented evaporation. In more detail, a six-hour Meso-LAPS forecast of specific humidity is compared to the screen-level specific humidity observations (more precisely, analysis). If the model forecast is drier than the observation at a point, the model root zone moisture is also assumed to be too dry and is subsequently increased by a soil moisture increment, using a model-specific tuning constant. This constant effectively relates the soil moisture increment to the screen-level specific humidity increment in fully vegetated areas.

Variation of soil moisture with time

Figure 5.1 qualitatively shows the time evolution of the model screen-level specific humidity and model root zone soil moisture. The left step function in both curves, for example, shows that the six-hour Meso-LAPS specific humidity forecast is too humid and is adjusted downwards guided by the actual observed specific humidity. Accordingly, the model-predicted root zone soil moisture is also adjusted downwards by an increment.

Limitations of inference-based techniques

The quality of this inference-based technique rises and falls with the degree to which specific humidity changes just above the ground are controlled by parameterised moisture fluxes from the root zone layer into the atmosphere. This relationship can be seen as a type of ``evapotranspirational balance'' (ETB). While it is clear

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.

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that the assumption of ETB does not always apply fully (e.g. in areas of strong lateral moisture advection in the lower atmospheric boundary layer),the nudging technique has been proven to substantially improve the representation of root-zone soil moisture inoperational numerical weather prediction models (Viterbo 1996).

The nudging scheme can be further improved by constraining the inferred soil moisture and soil temperature by two observational fields, the screen-level specific humidity and temperature. Again, an underlying balance assumption is made that a mismatch between the model and observed humidities/temperatures at screen level is informative regarding a mismatch between model and actual soil temperatures and soil moistures. This extended nudging scheme should be implemented by the end of 2002.

Reference

Viterbo, P., and A. C. M. Beljaars, 1995: An improved land surface parameterization scheme in the ECWMF model and its validation. J. Climate, 8, 2716-2748.Viterbo, P., 1996: The representation of surface processes in general circulation models. PhD thesis, University of Lisbon, 201pp. [Available from ECMWF, Shinfield Park, Reading, Berkshire RG2 9AX,United Kingdom.]

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PROGRAM 6
RIVER RESTORATION

Program Leader
IAN RUTHERFURD

Report by Ian Rutherfurd

Evaluating stream rehabilitation projects: the options are shrinking!

Project delivery and effectiveness

Typical stream rehabilitation actions include environmental flows, stabilisation structures, or riparian revegetation. At least $100 million is spent each year in Australia on such activities. Without doubt, the most common complaint about stream rehabilitation is that there is not enough evaluation of existing projects. There are two types of evaluation. Evaluation of project delivery ("did you do what you said you would?"), and evaluation of project effectiveness ("are there really more fish, better water quality, or less erosion than before the project began?"). Project 6.1 of the River Restoration Program is concerned with how we can efficiently establish the physical and ecological effectivenss of stream rehabilitation projects. This work is also supported with a grant from the MDBC entitled "Evaluating the effectiveness of habitat reconstruction" (a joint project with the CRC for Freshwater Ecology). In this article I will report on some of the potential evaluation approaches that we hoped would work – but probably won't.

Evaluating riparian projects

The most common stream rehabilitation approach in Australia is riparian revegetation and grazing management, so we investigated this as an example of rehabilitation. Most people are familiar with the many benefits that riparian vegetation have for streams, but it is quite a different matter to unequivocally establish these benefits.

There are several approaches that one can take to evaluation. The most obvious is to identify several similar reaches of stream, monitor various response variables (eg. water temperature, macroinvertebrate diversity etc.), then revegetate some of the reaches, and monitor the difference between the sites as the vegetation grows. The obvious problems with this before/after control intervention (BACI) design are the time that it takes to grow riparian vegetation, and the problem of finding sites that are sufficiently similar.

Using existing sites

Another appealing approach is to use existing revegetation sites. There have been thousands of riparian revegetation sites across eastern Australia over

PAST PRACTICE (1981 TO 1989)	• Revegetation performed only in conjunction with engineering works such as rock chutes. • Mainly exotics such as willows and poplars planted. • No management of the riparian vegetation.
INTERIM PRACTICE (1990 TO 1998)	• Combination of exotics (in channel) and natives (higher on banks) used. • Little management of riparian vegetation • Mainly carried out in conjunction with engineering works
CURRENT PRACTICE (1999 TO 2001)	• Revegetation recognised as a stand-alone restoration objective. • Species sourced locally and attempt made to imitate pre-disturbance density and composition (including consideration for understorey and aquatic species). • Management of riparian zone, such as stock exclusion and weed control, made a condition of CMA revegetation support to landholders.

Table 6.1: Changing practices in riparian restoration in N-E Victoria

PRACTICE	NUMBER OF SITES	STOCK ACCESS	INCISED	REMNANT VEG.	SAND SLUG	PLANTED ON ONE BANK	SUITABLE SITES
PAST	5	0%	20%	0%	20%	0%	60%
INTERIM	53	28%	28%	6%	0%	2%	43%
CURRENT	7	29%	14%	0%	0%	0%	71%
ALL	65	25%	25%	4%	1%	1%	46%

Table 6.2: Summary statistics for sites in N-E Victoria subject to riparian restoration.

the last 30 years. Surely we can learn something about the effectivness of this effort – even if the sites were not designed as an experiment. One method for doing this is to find revegetation sites that are similar in every respect, except for the age and characteristics of the vegetation. The premise then is that the difference between the sites will be a result of the age of the vegetation, thus avoiding the necessity to wait for trees to grow. This is a form of space-for-time substitution. Michelle Ezzy, an Honours student from the School of Anthropology, Geography and Environmental Studies at The University of Melbourne investigated whether this approach would be useful in the north east of Victoria, where there have been numerous riparian revegetation projects over the last 30 years.

Things were looking hopeful when Michelle managed to track down nearly 70 riparian revegetation sites that were more than 250 metres in length. She was ably assisted in this effort by officers of the North East and Goulburn-Broken Catchment Management Authorities, and the Department of Natural Resources and Environment. All of the sites were inspected.

Limitations of space-for-time method

The space-for-time method would only work if the age of the vegetation was the major variable to change. Thus, the species types, stand characteristics (eg. planting density), and stream morphology, would have to be pretty uniform across the sample. If this were the case, then we could compare, for example, the daily temperature range in reaches and explain some of that variability in terms of the age of the vegetation.

Unfortunately, the short answer is that all of the sites were so variable that there is little potential for learning much from the existing revegetation sites using a space-for-time approach. Most of the revegetation work that has been done in the past 30 years in north east Victoria has been done as part of other engineering works (especially of rock chutes in eroding gullies) (Table 1). Also, the types of vegetation planted have also changed from exotics to natives. Thus, the effect of the vegetation has been overwhelmed by the effects of the engineering works, stream incision, or variation in the vegetation type. Remarkably, only five of the 64 sites shown in Table 2 were pure revegetation sites, using native species.

Site differences

As a result of the different types of vegetation, the age of the vegetation stand is a poor predictor of stand characteristics, such as canopy density. Finally, all of the sites that have been revegetated are so different from each other (eg. in terms of channel dimensions) that it is

NEW CRC REPORT

THE CALCULATION OF STREAMFLOW FROM MEASUREMENTS OF STAGE

by

John Fenton and Bob Keller

Report 01/6

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

The main aims of the Project were to:

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

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

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impossible to isolate the effect of the vegetation (this difference persists when size is adjusted for catchment area).

Conclusions

To conclude, it would be great to be able to learn about the effectiveness of revegetation by comparing sites that have been revegetated at different times. However, results from over 60 sites in north east Victoria suggest that this is unlikely to yield much certainty.

As part of the MDBC project, we are now planning a major riparian revegetation project in the Murray-Darling Basin. There is also potential to monitor existing revegetation sites by measuring variables above, within and below the revegetation. The gradients of change between the sites may indicate the effects of the riparian management.

One thing is certain, there are unlikely to be any easy approaches to evaluating large scale interventions in riparian zones.

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PROGRAM 7
COMMUNICATION AND ADOPTION

Program Leader
DAVID PERRY

The Flow on Effect – February 2002

At a glance – a summary of this article

Some of the expected CRC products and activities for the first few months of 2002 including publications, workshops, model releases and updates by research programs are outlined.

Introduction

There is no doubt that 2002 will be a busy and productive year for the CRC. Many of the first round of three-year projects are concluding at the end of 2002 and planning is already underway for the next round of projects due to commence in early 2003.

The aim of this article is to give the reader an overview of upcoming CRC products and activities in the next few months.

Publications

There are many reports scheduled for publication over the next three months. Many represent conclusions and advances in knowledge from the previous two years of research. Reports to be published include:

- The Development of Water Reform In Australia (by John Tisdell, John Ward and Tony Grudzinski)
- The Status of Catchment Modelling (by Frances Marston, Rob Argent, Rob Vertessy, Sue Cuddy and Joel Rahman)
- Catchment Scale Modelling of Runoff, Sediment and Nutrient Loads for the South-East Queensland Environmental Management Support System (EMSS) (by Francis Chiew, Phil Scanlon, Rob Vertessy and Fred Watson)
- Estimation of Pollutant Concentrations for EMSS Modelling of the South-East Queensland Region (by Francis Chiew and Phil Scanlon)
- Stochastic Generation of Annual Rainfall Data (by Ratnasingham Srikanthan, George Kuczera, Mark Thyer, and Tom McMahon)

These reports will become available through the Centre Office over the next few weeks and advance orders (at $27.50 per copy) can be placed by contacting Virginia Verrelli on 03 9905 2704 or by email: virginia.verrelli@eng.monash.edu.au

'We All Use Water'

For industry, government, educators and communities wishing to expand their knowledge on water education and adult learning processes, the CRC for Catchment Hydrology - in conjunction with AWA - is presenting a professional kit 'We All Use Water' in six workshops in the eastern States during 2002. The kit's resources include a strong technical content as well as material to promote public understanding in water quality and catchment issues and community engagement in the discussion.

Two dates have so far been confirmed: 21-22 February in Shepparton, Victoria and 14-15 March in Sydney, New South Wales. Other workshops will be confirmed in Melbourne, Brisbane, Rockhampton and Canberra for 2002. For further information contact James Whelan <James.Whelan@mailbox.gu.edu.au>, Ph 07 3875 7457 and/or visit http://www.awa.asn/education/

MUSIC – Stormwater Decision Support System

The Urban Stormwater Quality Program will be releasing the first public version of MUSIC (Model for Urban Stormwater Improvement Conceptualisation) in March 2002. MUSIC is an urban stormwater decision support system that has been trialled in the Melbourne and Brisbane regions by Melbourne Water, Brisbane City Council and a number of consulting firms over the last 12 months. The response to MUSIC has been loud and clear – it is an effective tool for urban stormwater planning. A series of introductory seminars in Melbourne, Canberra, Sydney and Brisbane are planned for March and April 2002 with follow up training workshops towards the middle of the year. If you would like to know more details keep an eye on *Catchword*'s sidebars or subscribe to our events notification service at: www.catchment.crc.org.au/subscribe

Environmental Management Support System (EMSS)

The CRC for Catchment Hydrology and the South East Queensland Regional Water Quality Management Committee (SEQRWQMC) have developed a PC-based Environmental Management Support System (EMSS) for use in managing water quality across the south-east Queensland region. The EMSS predicts daily runoff, and daily loads of total suspended sediment, total nitrogen and total phosphorous from 180 different sub-catchments within the 22,670km^2 region, and routes these through over 2000 km of river network and seven major reservoir storages.

The model is designed for use by a range of end-users with varying levels of computer and technical proficiency and allows for existing component models to be easily replaced, and for additional ones to be added with minimal effort. Whilst the current version of the model is tailored for the SEQ region, it could be adapted for other large catchment systems. The CRC for Catchment Hydrology and SEQRWQMC see the EMSS being usefully applied elsewhere and are looking at collaborative arrangements with industry to promote its use.

The 'EMSS package' will be soon available on a CD. (Licencing arrangements are being finalised). For further information and a copy please contact Rob Vertessy at the Canberra node on 02 6246 5746 or email: rob.vertessy@csiro.au

NRE Information Centre

CRC publications can now be purchased through the Victorian Department of Natural Resources and Environment's Information Centre on the corner of Victoria Parade and Nicholson Street, East Melbourne. Our most popular publications are held in stock and CRC publications produced from January 2002 will be available. Further details are available at www.nre.vic.gov.au or contact the:

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CONFERENCE PROCEEDINGS

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

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

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

POSTGRADUATES AND THEIR PROJECTS

Our postgraduate for February is:

Andrew Barton

My path to Monash University and the CRC for Catchment Hydrology didn't just "happen."

Growing up near the rural city of Stawell in Western Victoria, it was here that I developed my liking for problem solving and admiration for the environment. These experiences eventually compelled me to move to Geelong to study for a Bachelor of Engineering (Honours) in environmental engineering from Deakin University. During my time at Deakin, I gained invaluable work experience with the Barwon Water Authority. Additionally, I undertook a major project as part of my degree with both Barwon Water and the Corangamite Catchment Management Authority who provided my project with insight and support.

After completing my degree, I relocated to Melbourne to undertake a CRC studentship at Monash University in December 2000 in Program 4 – Urban Stormwater Quality (Thanks Tony, Tim & Sara). It was during this studentship that I consolidated my desire to undertake postgraduate studies.

The vast array of research projects the CRC for Catchment Hydrology had on offer made it a tough task to choose the ideal research project, as I found many attractive. However, I soon found a project that suited my interests and would sustain my interest through the length of my candidature, which commenced in March 2001.

This project provided the potential to work in the areas of numerical and physical modelling of hydraulics. This was exactly my field of interest for further postgraduate education.

So here I am now working towards an MEngSc (by research) on improving the hydraulics of the vertical slot fishway.

Research problem

A fishway is a structure that allows passage of fish upstream and/or downstream of obstacles such as weirs, culverts, dams, tidal barrages and other instream structures.

The current focus of my research involves the development of a numerical model using a computational fluid dynamics software package called FLUENT.

The model will be used to provide a predictive capability for velocities and turbulence levels and their spatial variations within fishways. In particular the vertical slot fishway will be studied, as it seems to be a successful design for a wide variety of Australian fish types for a range of on-site conditions given the limited information currently available on its effectiveness.

Also, the vertical slot fishway is a very expensive structure to build, with an estimated cost of $100,000 for every vertical metre of fishway. Therefore any improvement in the understanding and design process, which will minimise costs yet improve effectiveness, is a clear advantage.

Research progress

To date, a preliminary numerical model has been developed to investigate the detailed flow characteristics of the fishway.

The flow within the fishway is characterised by a free surface, open channel type flow with contractions, turbulence, regions of high velocity, and flow separation at the vertical slot jet. Also present in the fishway cell are complex recirculation regions.

The model solves three dimensional flow equations, turbulence formulations, a free surface approximation, and wall function equations. This is seen as giving relatively accurate results given the flow physics within the available computational resources.

Results are aimed at establishing verifications for velocity distributions and depth variations within the fishway.

Predictions of turbulence and any secondary flow components and distributions will thus be developed based on these validations.

The numerical model will be verified by using data generously provided by Chris Katopodis, Regional Habitat Engineer, Central and Arctic Region, Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Manitoba, Canada. This data was taken from physical models completed at the University of Alberta, Canada.

Data collected by Lindsay White, a fellow fishways researcher at Monash University, will also be used to validate numerical models. Lindsay's data was taken from physical models completed at Monash University, and from the Torrumbarry Weir vertical slot fishway on the Murray River.

Future work

By using a numerical model, a detailed understanding of the flow behaviour beyond that readily available by experimentation (physical models and field measurements) can be achieved. An important consequence is the ability to use a computational fluid dynamics methodology that is both efficient and fully predictive for hydraulic analysis of fishways of this genre. This approach will eventually aid in the design process.

The final outcome of this research will be the ability to design a fishway by providing a given set of hydraulic characteristics, known to be preferred by given fish species.

It is envisaged that future work could involve developing some innovative designs for vertical slot fishways and possibly expanding the numerical modelling to other fishway types and configurations. Any such research may necessitate fieldwork and time in a hydraulics laboratory to verify the studies.

Final comments

My induction into the CRC for Catchment Hydrology team has been smooth and I now work within a fishways team that consists of Bob Keller and Lindsay White who have laid the groundwork for fishway research within the CRC and at Monash. They have enabled me to come aboard, together with postgraduate research student, Peter Kolotelo. Peter is an aquatic scientist by background who will conduct research into the fish biology, specifically areas of fish behaviour and physiology relating to fish passage.

I'm now currently debating the possibility of transferring to a PhD.

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CRC PROFILE

Our CRC Profile for February is:

Roy Rickson

Professor Roy E. Rickson has professional and research interests in: sociology of natural resources, community sociology, sociology of agriculture, organisational analysis, interdisciplinary analyses. In the context of these broader interests, Roy's research has been on how production and conservation activities and structures might be integrated on the farm and in the factory and community.

Studies include research on farmer responses to land and water degradation on their farms and in their communities. Organizational analyses of national and transnational agribusiness corporations, and other industries such as transnational cement companies have been undertaken, focusing on how their relationships with rural and urban communities have an effect upon local decisions about development, environmental quality and resource conservation. Current research sites are in Australia, Switzerland and Thailand.

Complementary research and teaching interests are community development and change affecting land use and other natural resource issues, and social assessment of development. Research and writing in social assessment has concentrated on the local social and environmental consequences of national, international and, increasingly, global production and planning structures. This work has discussed the basis of local community autonomy in large-scale corporate frameworks, ability of local communities to influence decision-making in that framework and local power and influence structures. Research and writing on interdisciplinary analyses has centred on establishing and managing interdisciplinary relationships and research teams.

In 1998, he received the Natural Resources Research Group Merit Award: "In recognition of outstanding contributions to the field of Natural Resource Sociology". Presented at the 61st Annual Meeting of the Rural Sociological Society held August 5-9, 1998 in Portland, Oregon USA.

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NEW TECHNICAL REPORT

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

by
John Tisdell
John Ward
Tony Grudzinski

Report 01/1

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

Copies available through the Centre Office for $27.50.

He co-supervises a large of number of PhD students specialising in industry/community relations for which he has received commendations from Griffith University for "excellence in supervision of honours and postgraduate students".

Roy E. Rickson
Australian School of Environmental Studies
Acting Dean
Faculty of Environmental Sciences
Griffith University
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Email: roy.rickson@mailbox.gu.edu.au

WHERE ARE THEY NOW?

Report by Sandra Roberts

As a graduate forest scientist in the early 1990s, it seemed that the only paying jobs I could get involved measuring trees. This work included measuring the diameter and height of giant mountain ash on the slippery slopes of the Otway ranges, measuring the diameter and height of pine plantations within their respective blackberry thickets, or measuring the heights and diameters of a variety of pine and eucalypt species destined for wood chip production in Gippsland.

I decided that I would further my education to provide an opportunity for a broader range of work tasks – this eventually led to my enrolment as a PhD candidate with the Department of Civil and Environmental Engineering at The University of Melbourne, funded by the CRC for Catchment Hydrology. Rob Vertessy, Leon Bren and Rodger Grayson were my supervisors. After a little discussion my topic was chosen – water yield and transpiration of *Eucalyptus sieberi* forests near Eden in NSW. My work here involved analysing water yield data from three of the Yambulla catchments, estimating the water use of individual trees of different age in the forest, and measuring the diameters and heights of trees for the extrapolation process. One of the more memorable aspects of this project was the time spent hand plucking the leaves from 126 eucalypts for leaf area estimates (just ask the 20 odd "volunteers" who helped – thanks guys!!).

My thesis was submitted in April 2001, and I was instantly off to my new job as a Research Officer with the Research and Development Division of State Forests of NSW. State Forests have been funded by the NSW State Salinity Strategy to benchmark the carbon sequestration and salinity benefits of planted forests in dryland salinity prone areas.

My task is to estimate the transpiration of a range of tree species planted on farms in the Macquarie, Namoi and Murrumbidgee catchments. Measurements of other water balance components and of biomass are being made in conjunction with the transpiration estimates. We're also collecting data for the development of growth models for tree species that may have potential for growth in dryland salinity prone areas. This involves identifying suitable trees on properties in the 500-700 mm rainfall zone and measuring their diameters and heights at regular intervals over the next three years.

So, after all those years of study I'm still measuring trees. However, now the mix of tree measurements, laboratory work, data analysis, and report writing is a little bit better balanced. I know where those tree measurements fit into the broader picture and I am able to analyse the data to help to further unravel the "how do trees affect hydrology" story. I also get to see more of rural NSW than a retiree with a caravan could ever dream of.

Thank you to everyone at the CRC and Melbourne University who has helped me along the way.

Congratulations on making the "cooperative" in the CRC for Catchment Hydrology's title so operative. My years with the CRC have not only been useful from a career development perspective, but also an enjoyable time, where I have made friends for life.

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The CRC for Catchment Hydrologys website

www.catchment.crc.org.au

Did you know that...

- **All of the current CRC's reports and many of the initial CRC's reports are available for downloading?**
  www.catchment.crc.org.au/publications

- **The CRC's website search engine searches the contents of pdf files as well as html pages.**
  www.catchment.crc.org.au/search

- **There is a wide variety of useful links to other websites including water focused email groups/servers etc.**
  www.catchment.crc.org.au/links

- **User information about many models developed by the CRC, and in some cases the actual model software, can be downloaded from the CRC models page**
  www.catchment.crc.org.au/models

- **You can receive up to date emails about activities the CRC is involved in e.g. recently published reports and upcoming workshops and seminars etc.**
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  www.catchment.crc.org.au/events

- **All of the CRC project description sheets are on the website as pdfs.**
  www.catchment.crc.org.au/programs

- **All CRC staff have their contact details listed on-line in a database – the CRC staff directory is also available for downloading as a Adobe Acrobat file**
  www.catchment.crc.org.au/contact

The CRC website is designed as a resource for those who want information about the CRC's research and its application

For further information contact David Perry on 03 9905 9600 or email david.perry@eng.monash.edu.au

CRC TOOLKIT WEBSITE

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

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

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

For further information contact
David Perry on 03 9905 9600 or email david.perry@eng.monash.edu.au

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OUR MISSION

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

OUR RESEARCH

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

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

CRC AUSTRALIA

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

Brisbane City Council
Bureau of Meteorology
CSIRO Land and Water
Department of Land and Water Conservation, NSW
Department of Natural Resources and Environment, Vic
Goulburn-Murray Water
Griffith University
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