NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 127 MAY 2004

A NOTE FROM THE DIRECTOR

Rodger Grayson

Inside...

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

TARGETS, DATA AND MODELS

Just as this issue of *Catchword* was going to press we heard that the eWater CRC has been asked to submit a stage 2 proposal, due in early July. This terrific news is a credit to the enormous amount of work by Gary Jones, Rob Vertessy, the Interim Parties Committee and all of the individual Parties in preparing the Stage 1 case. Thirty three out of the fifty two stage 1 submissions were invited to submit stage 2 applications. The next few weeks will be busy for all concerned, fleshing out the very strong set of products that have been proposed and building up the necessary research programs. It is expected that final announcements will be made late this year.

One of the important roles for eWater will be to provide information and tools to support the work of on-ground catchment managers around Australia. In July last year I joined the Board of my local Catchment Management Authority in East Gippsland. Over the past few months, the Authority, in collaboration with agencies and the community, has been preparing a new Regional Catchment Strategy (RCS). Each region of Victoria has developed an RCS, and similar strategies are part of catchment management Australia-wide. An RCS is a community led, strategic document intended to coordinate and focus a region's natural management effort towards priority projects, and sets the framework to guide regional investment. An important part of an RCS is the development of meaningful, measurable targets with time frames from a few years to several decades. This has been a major challenge for all involved in our RCS and my observation is that our experience is not unique. There is often a dearth of appropriate, accessible data on basic resource condition, and determining what level of target might be realistic to achieve is not easy. This experience set me wondering about how the work of CRCs might eventually assist groups like the CMAs in this difficult but important process.

Target setting, and reporting progress towards meeting targets is integral to virtually all natural resource management strategies nowadays, providing a mechanism for accountability and performance assessment. But while the concept is relatively simple, there is devil in the detail! Take a simple example of a nutrient load target for a catchment of say a 20% reduction over five years. What is the benchmark against which this reduction is to be measured – is it an average of the last five years, or ten years....? How accurately can we measure the load and so how sure can we be that the target has been met? What happens if the next five years have well above average rainfall and streamflow, or there are major disturbances such as bushfire that will create high loads irrespective of local management? Does this mean management has failed because the target was not met? Similarly a drought period may result in targets being met without any management intervention.

In practice, the setting of a target needs to take into consideration at least: the availability of existing data; the cost of collecting any new data; the notion of benchmarks; and methods for dealing with influences on the target other than the management actions that the target was intended to assess. In most catchments around Australia, data limitations are quite severe, so how can we maximise the efficiency of data collection and analysis to provide useful information to managers – including assessment against targets?

There are at least three approaches to consider – new technologies, improved data storage and retrieval, and the integrated use of modelling. New technologies in automated sample collection, real-time measurements and telemetry can provide virtually instant information. Advances in statistics are improving the "information content" of data by assisting in the design of sampling strategies that minimise redundant data and samples at critical times. Remote sensing has promised a great deal for many years, and is now starting to deliver with many of the new satellites intended for environmental applications. New algorithms are being developed for processing the remotely sensed data into useful information. But all these new data are useful only if they are efficiently accessed. The meteorology and remote sensing communities are well ahead in this area with national and even international data management and access facilities, often with almost real-time access to information. For water quality, biological and streamflow data, some States have developed on-line databases which are rapidly growing in capability, with enormous potential for enhanced accessibility. But data alone, even if easily accessible, goes only part way to helping us monitor against targets or better understand our systems. In particular, how do we deal with the fact

ANNUAL REPORT ON-LINE

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that the systems are constantly changing, not only because of management interventions but because of different weather, changes in population, changes in land-uses and so on. This is where modelling can play an important role.

Models can provide a method for interpolating between observations as well as dealing with the likely effects of differences in hydrological conditions between measurement periods. A model such as EMSS or MUSIC is designed to represent the hydrological and water quality response of a system for a given set of climatic, land-use and management conditions. These models are generally used to assess how different management actions or land-use changes would affect water quality and quantity, by running a range of scenarios over a particular climatic period. Used in this way, models can assist in the setting of realistic targets by simulating the effects of likely management actions and adoption rates over particular periods of time.

But models can also be used the other way around – for a particular set of land-use and management conditions, how do water quality and quantity change for different climatic conditions? This second mode is particularly important for the assessment of targets. By running a model over a particular climatic period, using the land-use and management conditions at the start of that period, the "expected value" of loads can be computed. This reflects what we would expect to see with no management intervention. If the observed loads over that period are much lower than this "expected value", we might conclude that the management actions undertaken during the period have been successful. Of course, uncertainty in both the data and the models means this comparison is not trivial, nevertheless, it is one of the few ways of interpreting targets in a meaningful way.

The utility of our models also stands to benefit greatly from the application of new technologies in measurement and data storage and retrieval. Imagine a situation where a model automatically interrogates on-line data bases and is ready to run immediately, providing real-time feedback to managers. This might sound like science fiction to those of us who plug away for months compiling and processing data to make our models work. But this is happening now, for example, the Bureau of Meteorology's numerical weather prediction models are run several times a day to provide us the latest forecasts. This sort of fusion of technologies has enormous potential to maximise the use of the data we collect and ultimately give us a much better understanding of the systems we are managing.

Target setting and reporting against targets is still a relatively new approach in natural resource management. It is fair to say that in practice our approaches are still quite crude, often "seat of the pants", due to limitations of time, data and the availability of more sophisticated methods. But we might look forward to a time when new technologies in data collection and archiving, in combination with integrated modelling, make target setting much more science than art. Each of these components is developing rapidly and our challenge now is to integrate and provide practical tools and methods that can be used as part of the process of developing targets such as those in the RCSs. We are making good progress, particularly with the models, but this is a long-term challenge that will no doubt be taken up in new initiatives such as the eWater CRC

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Report by Robert Argent

Whole-of-Catchment modelling

One of the activities being undertaken within Program 1 is the conceptual and technical development of the whole-of-catchment modelling capability that lies at the heart of the CRC for Catchment Hydrology 's mission. The target modelling capability for the CRC for Catchment Hydrology is being delivered largely through the expanding suite of software tools in the Catchment Modelling Toolkit. Additionally, a modelling capacity to undertake whole-of-catchment (WOC) analyses, making use of the majority of Toolkit modules, and covering a wide range of water and land management issues, will be developed. An example of the style of WOC modelling envisaged is the EMSS for South-East Queensland, although simpler WOC models and systems (e.g. CMSS, AEAM-style models) are also included.

This article introduces the basic concepts of the CRC for Catchment Hydrology 's main integrated WOC modelling tool, known as E2. E2 is an extension of the EMSS concept and all the capabilities of that model will be built into E2, along with significant enhancements that enable better integration with other CRC for Catchment Hydrology products. E2 also encompasses a broader modelling philosophy, of providing a flexible modelling structure that allows users to select a level of complexity appropriate to the problem at hand and the available data and knowledge. Thus, the intention with E2 is to not only provide a better modelling tool but also to provide the kind of capability needed to also improve the style and operation of natural resources modelling in Australia.

E2 will predict the hydrologic behaviour of large catchments (e.g. 10,000 - 140,000 km^2), made up of tens to hundreds of sub-catchments. The main model structure is "node-link", where sub-catchments feed water and material fluxes into nodes, from where they are routed down links. Spatial data of elevation, land use and management, climate, geology and soils are linked to this spatial structure. E2 will be able to predict the flow and load of sediment, nutrients, and salt at any point in a river network over time, operating at daily or sub-daily time steps and reporting on monthly to decadal scales. Ecologic consequences, such as changed habitat and riverine ecologic health, will also be available.

The development of E2, and particularly the integration of a range of different modelled concepts, will naturally require detailed specification – of both the technical workings and the user-software interaction. This level of detail will be defined over coming months through interactions within Program 1 and detailed discussions with relevant other Program and Project leaders, and will be described in a series of detailed model

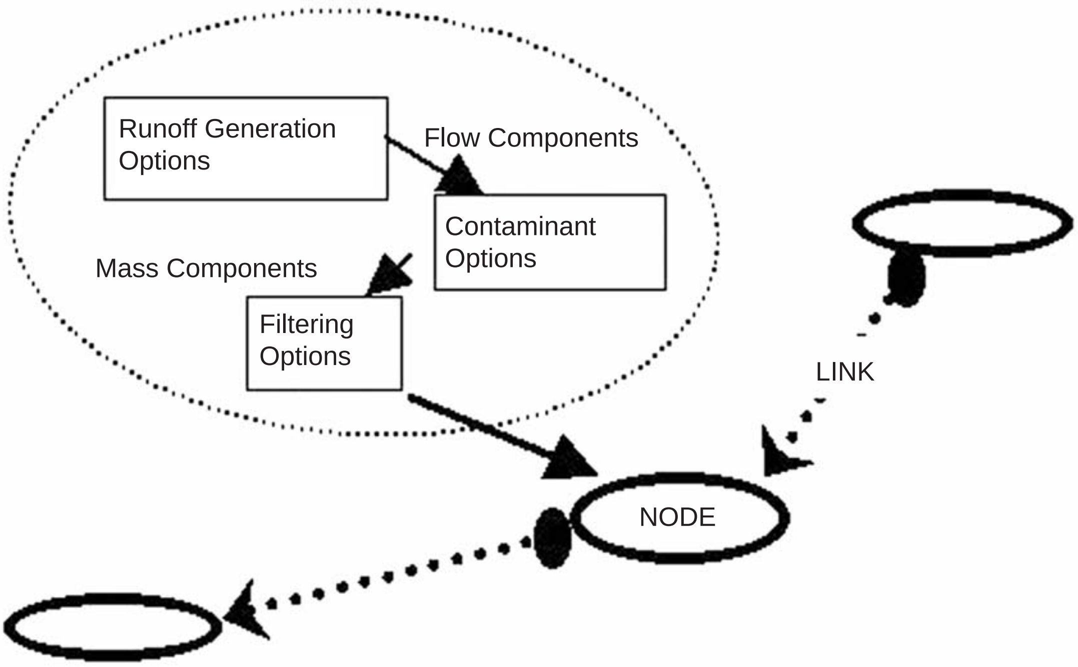

Figure 1.1 Basic Structure of E2

RECENT TECHNICAL REPORT

The Effect of Afforestation on Flow Duration Curves

By
Patrick Lane
Alice Best
Klaus Hickel
Lu Zhang

Technical Report 03/13

This report is part of a series that bridges the gap between the science of catchment water balances and the management of rivers for a range of outcomes by considering the impact of afforestation on flow distribution throughout the year.

Printed and bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

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CATCHMENT MODELLING SOFTWARE

Further information about the Catchment Modelling Toolkit is available at www.toolkit.net.au

Visitors to the site can access a range of catchment modelling software online by registering as a Toolkit member. See www.toolkit.net.au/register

specifications. One of the keys in this development will be the use of modules and models developed by CRC for Catchment Hydrology projects, such as the Stochastic Climate Library, MUSIC, SedNet, and the River Analysis Package. It will also be important to have an application that will allow these modules to be flexibly combined to provide a range of model scales and complexities for predicting behaviour at the whole-of-catchment scale.

Overall Structure

E2 will be a node-link style model, with generation and filtering of flow and material taking place in sub-catchments, from where they pass to a node before being routed and processed along links (Figure 1.1). The major components of the model are broken into blocks of options (e.g. runoff generation, contaminant generation, filtering) related to particular processes. This is to enable a "menu" of different algorithms to be available for each process.

A range of inputs will be used, such as topography, climate and land use/cover, with climatic data generation and some model parameterisation supported by the Stochastic Climate and Terrain Analysis Libraries, respectively. Each sub-catchment will be able to have different sets of parameters for a given model structure, and "Functional Units" (FUs – "foos"), covering parts of sub-catchments with similar nature, will be defined to improve calculation efficiency. Simple FUs may be based on land use alone, while more complex "hydrological response"-type FUs may be based on landscape position, land use/cover, and erosivity/hazard.

A 'management' layer will be integrated with this structure, to provide communication between nodes, supporting the system control required by processes such as irrigation water demand and supply, or salinity and nutrient targets. A sub-surface modelling structure will also be defined to handle sub-catchment and link, surface-groundwater interactions.

Using E2

E2 will support various modelling structures and approaches, built around a module-based approach to modelling. The system will support not only modular modelling but also hierarchical modelling, where a user can start modelling at a coarse level of detail to build an understanding of the 'big picture', and can apply more detailed models across all sub-catchments or in selected areas, as needed to answer more refined questions. Alternatively, E2 will also support the application of a fixed or standard model structure to all sub-catchments, with either global parameters or individually selected parameters, similar to the current EMSS.

Users will generally develop and parameterise models in three panels (Figure 1.2), as follows:

- A network view, showing the node-link system;
- A sub-catchment 'canvas' showing the structure of modules representing the processes operating in a sub-catchment, and supporting visual placement and linking of modules, and
- A link view, showing the processes/modules operating along links

These panels will have associated with them various system information and parameterisation screens to support management and surface-groundwater model sub-systems, as well as to support general model operation.

A typical model construction process may contain steps for:

i) identification of relevant fluxes, targets, and management actions
ii) sourcing or generation of spatial and temporal data
iii) creation of network, sub-catchment and link model structures using selected modules
iv) definition of uncertainty specifications

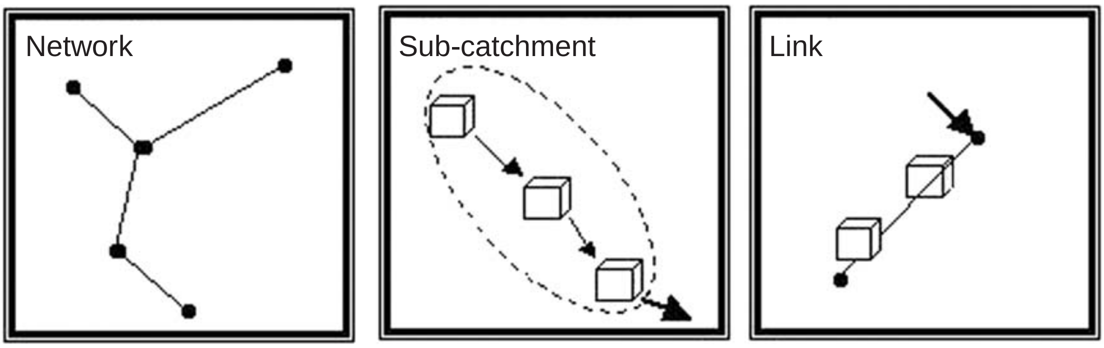

Figure 1.2. Network, Sub-catchment and Link Screens

v) parameterisation and calibration of models, including storages and other control features

vi) scenario operation.

The above paints an ambitious picture of development for E2, which will take place over the next 12 months. E2 will be developed over a number of phases, each with an associated release. The first release, timed for July 2004, will provide a CMSS-like capability with flow routing, including:

- a basic user interface and shell,
- the ability to express scenario changes via text,
- core modelling for flow routing, node-link representation, sub-catchment delineation and imposition of nodes, generation of FUs, selection of modules from "libraries", and
- core system information management capability.

Further releases in late 2004 and early 2005 will provide further features and enhanced core capability, leading to delivery on our vision of a 'whole-of-catchment' predictive modelling capability.

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RECENT TECHNICAL REPORT

The Impact of Rainfall Seasonality on Mean Annual Water Balance in Catchments with Different Land Cover

By
Klaus Hickel
Lu Zhang

Technical Report 03/11

Our understanding of catchment hydrology is approaching the point where we can confidently predict the partitioning of rainfall and how it changes when we change the land use. This report describes some of the research that supports this important development. By enabling the consideration of seasonality, it enables more confidence in our prediction of how catchment hydrology changes when land use changes.

Printed and bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

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NEW TECHNICAL REPORT

Changes in Flood Flows, Saturated Area and Salinity Associated with Forest Clearing for Agriculture

By
Richard Silberstein

Technical Report 03/1

This report presents results of an investigation into the connection between stream flow and the rise of watertables following clearing, and their fall after reafforestation. The main focus is to identify as well as possible the relationship between high flows and saturated area. While there remains work to be done to completely fulfil the aims of the project, a number of key results are reported.

Printed and bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

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

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER WALLBRINK

Report by Carol Conway, Christy Fellows and Kit Rutherford

CRC linkages with the national rivers contaminant program

Introduction

Research carried out in North America and New Zealand has highlighted that riparian zones can play an important role in the reduction of the amount of nitrogen that is able to enter neighbouring waterways though promoting the process of denitrification. Denitrification, a microbial process that consumes nitrate by converting it to nitrogen gas, is being considered as a management tool for improving river water quality, and is a focus of a current CRC for Catchment Hydrology second round project, Project 2.22 (2D) titled: "Modelling and managing nitrogen in riparian zones to improve water quality". This builds on the findings of a previous project round in the CRC for Catchment Hydrology, including Project 2.5: "Nitrogen and carbon dynamics in riparian buffer zones". This involved a detailed study of a perennial stream (Coochin Creek) and an ephemeral tributary, and was conducted in collaboration with the CRC for Coastal Zone, Estuary, and Waterway Management. Field and laboratory work investigated surface and groundwater hydrology and chemistry, rates of nitrate removal, and denitrification potential of subsurface soils and aquifer sediments. An overview of the findings of Project 2.5 was provided by Heather Hunter in a June 2003 *Catchword* article.

The CRC for Catchment Hydrology Project 2.22 (2D) is also being conducted at the Coochin creek site. It aims to provide further insights into groundwater-surface water interactions and riparian processes in large perennial systems, by developing a model to predict denitrification in riparian zones for incorporation into the CRC's toolkit catchment water quality model/s, and assessing the potential for riparian zone management to moderate nitrogen fluxes in catchments. This work is now also being complemented through research being conducted through The National Rivers Contaminants Program (NRCP). The NRCP aims to develop managing strategies for contaminants such as salt, nutrients and sediments to reduce adverse effects on ecology, and continues the partnership between Land and Water Australia and the Murray-Darling Basin Commission from the preceding National Eutrophication Management Program that focused on algal blooms.

This report provides an introduction to some of the NRCP projects that have strong linkages with ongoing CRC for Catchment Hydrology activities and will be used to improve and strengthen the outcomes of this CRC's research. These are: GRU28 "In-stream and riparian zone nitrogen dynamics" (hereafter GRU28) and CLW55 "Development of a catchment contaminant cycle model for stakeholder use" (hereafter CCCM).

Managing nutrient contamination

The need to manage catchment contaminants stems from understanding that contaminants affect not only the health and ecology of riverine systems, but also threaten consumptive and commercial uses of freshwater resources. The goal is improved water quality of Australian streams and rivers to meet the community's objectives of maintaining ecological integrity and biodiversity, to promote sustainable use for current and future generations. This includes forming a better understanding of river contamination issues, reducing management costs and the risks that lead to river contamination.

A survey of water managers conducted for The National River Contaminants Program in 2000 indicated that the main issues of concern were salinity, nutrients, sediments and to a lesser extent, pesticides - so these are the main areas that are currently being addressed. The preceding National Eutrophication Management Program clearly identified the processes and practices that favour algal bloom outbreaks, such as soil erosion, excessive and inappropriate fertiliser use; runoff from intensive agriculture; nutrient release from sediment accumulated in rivers; water flow regulation and point source effluent discharges. It also demonstrated that the nutrient most limiting to phytoplankton growth in a number of waterways was nitrogen.

However, the program also highlighted several gaps in our understanding of algal bloom outbreaks in Australian waterways. Several of these involved areas that have been previously identified by the CRC for Catchment Hydrology as being essential for promoting better management practices within Australian catchments, including:

- carbon and nitrogen transformations within riparian systems, leading to an understanding of the circumstances in which nitrogen is likely to be a significant management issue and how it may be managed

- investigating and quantifying the links between surface and sub-surface nitrogen movement through riparian zones, and interactions with adjacent streams, and
- developing this research into guidelines and knowledge tools for use by managers at farm, community, region, State and Federal levels.

Several of these gaps are currently being addressed in CRC for Catchment Hydrology projects such as 2.22 (2D). However, the concepts that emerge from this research now have a means of becoming strengthened through the two parallel studies GRU28 and CCCM. These studies will allow our CRC for Catchment Hydrology research findings to be tested and applied in a wide range of climatic, hydrologic, and physiographic settings typical of Australian catchments.

In-stream and riparian zone nitrogen dynamics - a regional comparison of denitrification potential

Our research in the River Contaminants Program involves applying some of the methods developed in CRC for Catchment Hydrology Project 2.5 at a broad range of field sites in south-east Queensland, as well as southern Victoria, and southern Western Australia. These regions have been chosen due to their contrasting climates and soil types, as well as the fact that conceptual model development can draw on data from past and ongoing research we are conducting in the regions.

The overall outcomes will be an improved understanding of key ecological and hydrologic links between riparian zones and their associated streams and how these links influence nitrogen and carbon cycling. This information is essential to the ecologically (and economically) sustainable management of these important ecosystems. Working across these three regions should allow us to assess the applicability of our findings from CRC Project 2.5 to a wide range of conditions. Conversely, the rates of denitrification potential and the distribution of organic carbon in stream sediments and riparian zone soils obtained from this project will feed into the modelling efforts of the two projects: Project 2.22 (2D), which is also a collaborative effort with the Coastal Zone CRC; and the CCCM Project of the National River Contaminants Program. Both of these projects will deliver models through the Toolkit.

Development of a catchment contaminant cycle model (CCCM) for stakeholder use - Integrating outputs

To identify the optimal management strategies it is necessary to know where in the catchment contamination occurs (the sources), how much of what is generated at each source reaches the impacted site (the delivery ratio) and the times scales involved.

Computer models for contaminant cycling

A number of computer models have been developed to address contaminant cycling, including several in the Toolkit. EMSS, for example, simulates the spatial and temporal distribution of nutrient and sediment generation, plus the attenuation that occurs during downstream transport. However, it is generally accepted that more input data, calibration and in field-testing will allow EMSS to be even further refined. There is also an awareness that to date, a large body of information about the effects of contaminants on stream ecology has not been incorporated into such models.

Improving modelling capabilities

The CCCM project aims to further compliment CRC Catchment Modelling Toolkit products to order to improve catchment modelling capabilities. There are three steps to this project.

Firstly, a survey was conducted during 2003 of the needs of end-users of catchment models. The survey used an online questionnaire which elicited 100 responses. Findings supported those of an earlier survey (2000) that sediment, nutrient and salt were the contaminants of major concern. It identified the need to model the effects of land-use change, riparian zone and flow management, and point source control. It also identified the need to simulate the effects of contaminants on ecological functioning and habitat values, notably floodplain and riparian vegetation, macroinvertebrate population and algal biomass. Models need to be applicable over a relatively large range of spatial scales, and results need to be communicated effectively to end-users using simple methods (e.g., maps). Overall, improvements are required in the estimation and representation of uncertainty in model outputs.

Secondly, as the result of a two-day workshop involving researchers and funders, six working groups have been established and charged with developing a new predictive 'module' that will eventually be incorporated into the toolkit. Careful attention is being given to the end-user needs previously identified. While it is the intention that the new 'modules' produced by these groups will be incorporated into the CRC's Catchment Modelling Toolkit, the funding streams and timetables are not the same. Consequently, the groups will aim to develop their modules as 'stand alone' products that will including computer coding, testing, documentation and (hopefully) publication.

Thirdly, the modules will be tested by stakeholders in our two demonstration catchments: the Murrumbidgee and Brisbane Rivers.

MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

Impact of Increased Recharge on Groundwater Discharge: Development and Application of a Simplified Function using Catchment Parameters.

By

Mat Gilfedder
Chris Smitt
Warrick Dawes
Cuan Petheram
Mirko Stauffacher
Glen Walker

Technical Report 03/6

This report describes the development of a simple approach towards estimating the response of groundwater systems to changes in recharge that arise from changes in land-use. The emergent properties of a groundwater system are examined using scaling arguments, by combining the effect of aquifer properties into a single dimensionless groundwater system similarity parameter (G).

This report is available as an Adobe .pdf file only.

Visit www.catchment.crc.org.au/ publications and search under 'Land-use Impacts on Rivers'

Synergies between National River Contaminants Program and CRC for Catchment Hydrology
The National River Contaminants and CRC for Catchment Hydrology programs are being managed so that they complement each other. For example the new salinity effects module is being developed within the CCCM project in response to an agreed need to fill an information gap in the proposed new catchment-scale salinity model being developed within the CRC for Catchment Hydrology as part of an extension of the EMSS concept (currently called 'E2'). There is already model development underway within the CRC for Catchment Hydrology on nitrate transformations in riparian zones (Project 2.22 (2D)). The riparian nutrient transformations working group within the CCCM project aims to add value to this work where possible using findings from other relevant studies. In this way, research being conducted within the CRC for Catchment Hydrology is providing a platform for integrating catchment contaminant research, so that better modelling products can be developed for managers.

More information on the National River Contaminants Program can be found at:

http://www.rivers.gov.au/research/contaminants/index.htm

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Report by Lu Zhang and Jenet Austin

Estimating the impacts of climate change on catchment salt and water balances

Introduction
In early 2003, the Australian Greenhouse Office (AGO) initiated a pilot project with CSIRO Land and Water and the Climate Impact Group from CSIRO Atmospheric Research to investigate the impact of climate change on salt and water balances in three catchments in Victoria under changed land-use conditions. The approach used in this work to assess water and salt balances was developed as part of the research undertaken in CRC Project 2.3: Predicting the effects of land use change on catchment water yield and stream salinity.

The reasoning behind the AGO's request for such a study was due to the fact that limited consideration of potential climate change impacts has been given in the development of regional natural resources management (NRM) plans. The impact of climate change can affect the outcomes of regional NRM interventions currently being planned and implemented. This may cause some outcomes to differ from what is currently anticipated.

For example, establishment of perennial vegetation for multiple benefits is a major priority in many regional NRM plans. Given that hydrological responses to revegetation may occur over many years, consideration of the potential impacts of climate change is important in devising targeted revegetation strategies that maximise benefits and minimise negative outcomes.

Focus Catchments Locations, Data Sources and Methods
Three focus catchments in Victoria were chosen for this study; Bet Bet Creek in the Loddon Catchment, and Sheep Pen Creek and the South West Goulburn within the Goulburn catchment. The focus catchments have a range of woody vegetation cover, mean annual precipitation, and groundwater flow system (GFS) combinations. They also represent typical land-use, groundwater flow systems, and hydrologic characteristics of the major river basins in Victoria.

- Climate data and scenarios

  The climate change data used in this work were supplied by CSIRO Atmospheric Research, and included a baseline dataset as well as two scenarios, projected for two periods into the future 2030 and 2070. The climate change scenarios were derived from two regional climate models (RCMs), the CSIRO DARLAM 125 (125km – D125) RCM and the CSIRO Cubic Conformal (50km – CC50) RCM. These models take data from the CSIRO Mk2 Global Climate Model (GCM) and, using a finer resolution grid and topography, produce estimates of local changes in temperature, precipitation, potential evapotranspiration and atmospheric CO_2.

- Other data

Other input data included a modified version of the Murray-Darling Basin Commission (MDBC) M305 vegetation dataset (representing current woody vegetation cover), 1:1,000,000 scale groundwater flow systems data from the National Land and Water Resources Audit, and a rainfall salinity surface.

The Biophysical Capacity to Change (BC2C) model was used to estimate changes in water and salt yield, and salinity (measured as electrical conductivity – EC) from baseline for each of the two climate scenarios (CC50 and D125) and the two time periods 2030 and 2070, for each of the three focus catchments.

- General water and salt yield results

Overall, the results show reductions in water yield and salt yield for all three catchments, however, changes in flow weighted EC are variable. As expected, the reductions in water and salt yields are greater under the CC50 scenario than under the D125, since less precipitation and higher potential evapotranspiration are predicted by the CC50.

- Catchment results

Results for Bet Bet Creek and Sheep Pen Creek showed little spatial variability due to small catchment area and few groundwater flow systems. However, the South West Goulburn catchment exhibited strong spatial patterns. The model predicts that by 2030 climate change will have little impact on flow weighted EC in the South West Goulburn. However, by 2070 the impact of climate change becomes obvious showing decreased EC in some parts of the catchment as most of the groundwater flow systems within the catchment would have responded to climate change by then.

- Salt exports

Characteristics of the groundwater flow systems (GFS) present in each of the three catchments determine much of the salt export behaviour. Sheep Pen Creek and Bet Bet Creek are dominated by intermediate and regional GFS, which means they will take decades to centuries to fully express changes in the surface water balance due to either climate or vegetation change, or a combination of both. Model results show only the short-term effects where the dilution effect of surface flows has ceased long before groundwater discharge can respond similarly, i.e. long-term groundwater changes will occur, but over a

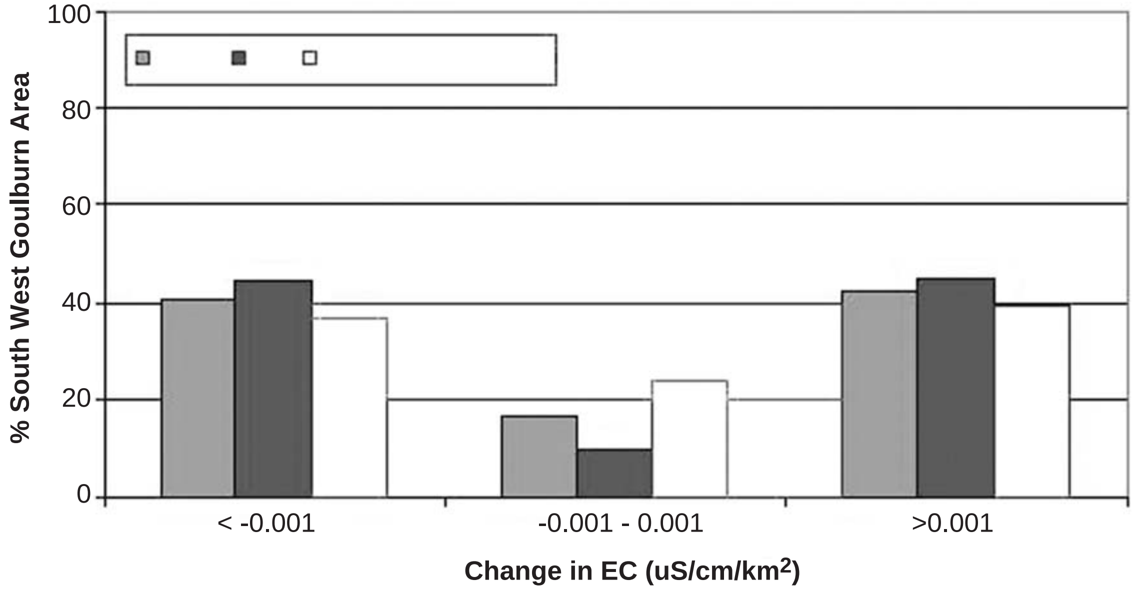

Figure 2.1. Changes in flow weighted EC in the South West Goulburn relative to the Goulburn catchment under different climate change and revegetation scenarios.

MDBC-CSIRO-CRC TECHNICAL REPORT SERIES

Testing In-Class Variability of Groundwater Systems: Local Upland Systems.

By

Cuan Petheram
Chris Smitt
Glen Walker
Mat Gilfedder

Technical Report 03/8

This report assesses the extent information can be transferred between hydrogeologically similar catchments, by investigating in detail one set of similar catchments.

Assessment of Salinity Management Options for Kyeamba Creek, New South Wales: Data Analysis and Groundwater Modelling.

By

Richard Cresswell
Warrick Dawes
Greg Summerell
Glen Walker

Technical Report 03/9

This report describes a study of the hydrogeological factors influencing salinity in the Kyeamba catchment, located within the uplands of the Lachlan Fold Belt of south-eastern Australia.

These reports are available as Adobe .pdf files only.

Visit www.catchment.crc.org.au/publications and search under 'Land-use Impacts on Rivers'

longer period than the model predictions. Thus while salt flux decreases slightly, stream salinity increases greatly. The South West Goulburn catchment is dominated by local GFS and responds differently to climate change and/or revegetation. The model predicted that climate change is likely to result in decreased EC in about 40% of the catchment by 2070 (Figure 2.1).

- Water balance sensitivity

  The sensitivity of the water balance model used in BC2C is greatest to rainfall and less to potential evapotranspiration. However due to differences in the magnitude of change of each component, the total contribution to reduced runoff from rainfall is less than that from potential evapotranspiration. The results suggest that percentage changes in rainfall will be amplified in runoff. Using these sensitivities we can gain a rapid assessment of the gross changes in excess water for an arbitrary change in rainfall and potential evapotranspiration.

Implications and Further Work

The results from this project demonstrated clearly that climate change can have a significant impact on the water and salt yields, and thus salinity. Climate change will pose challenges to natural resources management and its impact on water resources should be considered together with land-use change impacts so that trade-offs and synergies are appropriate. Spatial patterns of changes in salt and water balances within a catchment are partly controlled by groundwater flow systems.

Further work will include an assessment of the impacts of climate change on the water and salt balance for the entire Murray-Darling Basin, and sensitivity analysis of hydrological models to climate change.

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PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Erwin Weinmann, Barry James and Hector Malano

Modelling the impacts of temporary water trading in the Goulburn-Broken catchment

Project background

The main aim of Project 3.08 (3A) 'Hydrologic and economic modelling for water allocation', led by Dr Bofu Yu of Griffith University, is to enhance the existing water allocation modelling capabilities to allow the simulation of temporary water trading and to assess its impacts on water users and on the regional economy. In recognition of the two significantly different modelling approaches adopted in different states, separate tools are being developed to link in respectively with the IQQM water allocation model used in New South Wales and Queensland, and the REALM model used principally in Victoria.

This article deals specifically with the REALM component of Project 3.08 (3A), which focuses initially on the Goulburn-Broken catchment. The team involved in the conceptualisation, development and trial application of the enhanced modelling capabilities includes researchers from 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), Goulburn-Murray Water (GMW), and SKM as an Industry Affiliate. Previous *Catchword* articles have described the Goulburn-Broken catchment (Dec. 2002), initial work on this project component (May 2003), and related work in an Associated Project (July 2003).

The REALM modelling framework

The generalised computer simulation package REALM (REsource ALlocation Model) facilitates the building of models to simulate the operation of complex integrated water supply systems such as the Goulburn System in Northern Victoria. The Goulburn System model, referred to as 'GSM', covers the Goulburn-Broken catchment as well as the Campaspe and Loddon catchments. The model represents the many separate inflows and 20 storages that act as sources of supply to the system and the various rural and urban demands that are aggregated into 58 demand areas. The allocation of supply to the different water demands is simulated in accordance with a set of rules and constraints using a monthly time step. The water requirements at irrigation demand nodes are estimated externally to the GSM using the Program for Regional Irrigation Demand Estimation (PRIDE).

To reflect the impacts of highly variable climate conditions on water demand and supply for a given allocation scenario, the GSM is typically run over a 110-year simulation period, using the best estimates of historic streamflow, rainfall and evaporation data. The simulation model outputs are in the form of time series of monthly deliveries to each of the demand nodes, storage volumes in the reservoirs, and other hydrologic indicators of system performance over the simulation period.

Simulation of temporary water trading

The Water Re-Allocation Model being developed for the REALM modelling framework (called WRAM-REALM) is based on the assumption that the net volume of water traded between irrigation demand nodes is determined principally by economic drivers, and modified by a set of constraints which reflect the influence of trading rules and physical system constraints. For given set of seasonal irrigation water requirements and availability of supply at an irrigation demand node, the economic drivers for water trade can be represented as schedules of excess demand and supply volumes for a range of water prices.

The estimation of these excess demand and supply curves makes use of the extensive experience of Department of Primary Industry economists in modelling Victorian irrigation farming systems. The DPI Regional Water LP model optimises the allocation of water to the key agricultural industries in the region (dairy, mixed farming and horticulture), subject to a set of constraints. The influence of seasonal climate conditions on optimum allocation is accounted for by determining demand and supply schedules for 15 different combinations of irrigation requirement and supply availability for each irrigation demand node.

A PhD research project undertaken by Asif Zaman at The University of Melbourne, under the supervision of Associate Prof Hector Malano, is exploring econometric approaches to estimate demand and supply curves for irrigation water in the Goulburn-Broken region (Zaman *et al*, 2004). The results of this research are expected to provide additional information for the simulation of temporary water trading in water allocation models.

Impacts on regional economy

The impacts on the regional economy of different water allocation scenarios, with and without water trading, will be assessed through an input-output model, which

NEW TECHNICAL REPORT

Nature, Preparation and Use of Water Accounts in Australia

By
Manfred Lenzen

Technical Report 04/2

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

Printed and bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

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

uses water accounts generated by REALM as a main input. The input-output model for the Goulburn-Broken catchment is still under development; it will use the principles outlined in Lenzen (2004)

Integration of modelling components

A substantial part of the effort involved in the development of the enhanced modeling capabilities has been made in defining how the different modelling components can be made to interact most efficiently. This development process has benefited greatly from the experience of the industry parties in running REALM-GSM and similar irrigation system models. Close cooperation between DSE, Associate Professor Chris Perera of Victoria University and SKM, who maintain the REALM code, has ensured that the integrity of the existing REALM code is preserved.

Figure 3.1 below illustrates how the different components of the modelling framework are integrated. At the end of each year of the simulation period, the normal REALM-GSM run is interrupted to estimate the volumes of trade for the irrigation season and to rerun REALM-GSM with modified water entitlements for the nodes. Entitlements are modified as a result of this trade volume. The re-run allows the effects of delivery constraints to be simulated in detail.

Current work and outlook

The development of the WRAM-REALM module and the associated integration components has reached a stage where the initial testing is being conducted on the current version. Based on the results of this testing phase and the comparison with actual temporary water trading data for the last few years, a few enhancements of this initial version are envisaged before the new modelling capabilities will be made available for application by the main users, the Department of Sustainability and Environment and Goulburn-Murray Water.

References

Lenzen, M. (2004) Nature, preparation and use of water accounts in Australia. CRC for Catchment Hydrology Technical Report 04/2.

Zaman, A, Davidson, B and Malano, H.M. (2004) What is driving temporary water trading in the Goulburn-Broken Catchment? 48th Conference of the Australian Agriculture and Resource Economics Conference. 29 pages.

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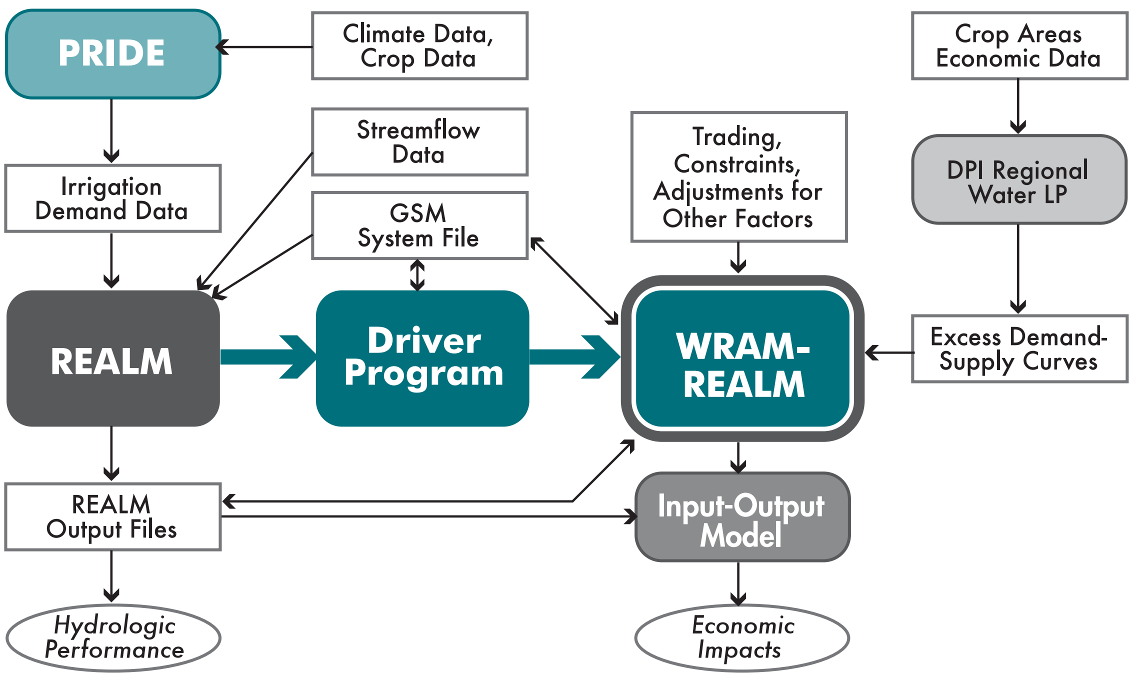

Figure 3.1 Integration of components of the modelling framework

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Peter Poelsma

Community environment project – CERES

One fortunate consequence of the drought is the increased support for water projects in organisations not accustomed to receiving this kind of support. CERES (the Centre for Education and Research in Environmental Strategies) is a community environment project located beside the Merri Creek in Brunswick, Melbourne. In late 2002, CERES obtained a $350,000 Science, Technology and Innovation (STI) grant for their Urban Water Conservation Demonstration and Research Facility, launched by the Premier and attended by a large media contingent. The following year a $160,000 Victorian Stormwater Action Program grant provided supplementary funding allowing for an increased focus on improved stormwater management. This includes demonstrations of biofiltration systems, roof water and surface runoff harvesting, and the development of student, community and industry education programs. The CRC for Catchment Hydrology is providing advice on the location, design and construction of some of these techniques for stormwater collection and treatment.

CERES is a non-profit community-based organisation that aims to foster awareness and action on environmental and social issues affecting urban areas. Located on an old landfill, the four hectare site has displays and functional demonstrations on a range of environmental issues to show just what can be achieved at household, community and global levels. CERES has 200,000 visitors each year, including around 60,000 students - from pre-schoolers to postgraduates. About 140 workers, hundreds of volunteers, the meeting of many community groups, community gardens, a nursery, café and markets ensure that the local community also have regular contact with the site.

Project development

The Urban Water Conservation Demonstration and Research Facility at CERES is being developed with assistance from the CRC for Catchment Hydrology, RMIT, CSIRO, EPA Victoria, local council, Yarra Valley Water, and several consultants. This project will demonstrate the latest technologies for water conservation, recycling and reuse in a variety of settings, including the home, nursery, café, organic farm and community centre. Through site demonstrations and education programs, the importance of behavioural change and the move to sustainable behaviours will be communicated to tens of thousands of people.

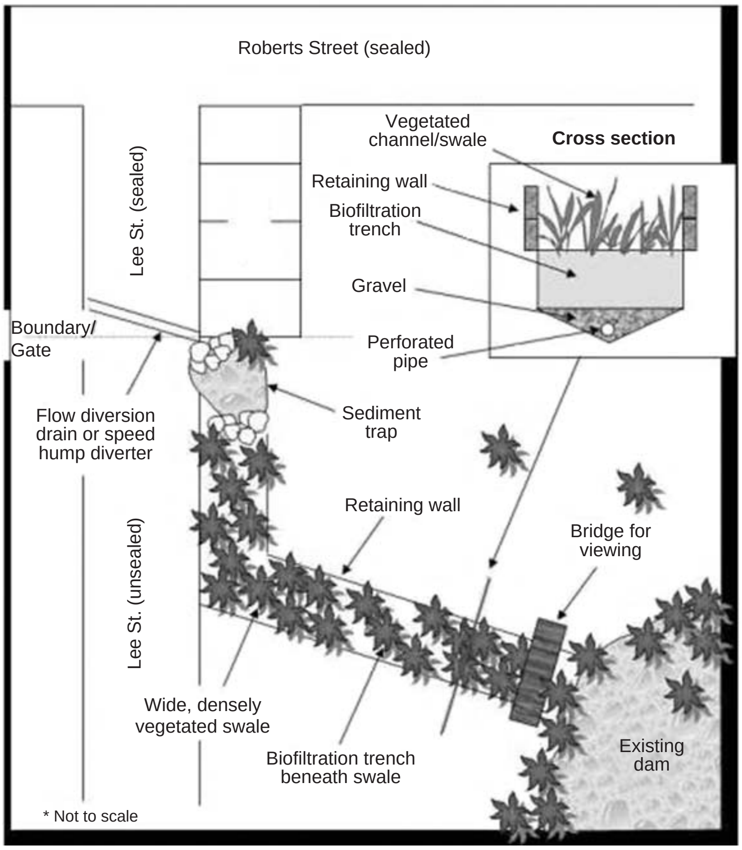

Figure 4.1. CERES Lee Street Biofiltration System

This project has provided CRC for Catchment Hydrology researchers with an opportunity to design and monitor stormwater treatment systems whilst CERES and downstream waterways receive the benefits of improved water quality. The system is then built at CERES using funds from the grants and is available for monitoring. It's a bit like having a laboratory setup built for free in the field!

Biofiltration system

Figure 4.1 shows the biofiltration system designed to treat runoff from a sealed carpark and two sealed streets. The system was designed to treat the one-year flows and safely convey the five-year flows on the swale surface. A 'speed hump diverter', basically an angled speed hump, was sized to divert up to the five-

URBAN STORMWATER SOFTWARE

Model for Urban Stormwater Improvement Conceptualisation (MUSIC) version 2

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

MUSIC Version 2 is available as a free evalution Version download from the Catchment Modelling Toolkit website at www.toolkit.net.au/music

The MUSIC evaluation version allows you to trial the MUSIC software for 6 weeks. During that period you are able to purchase the MUSIC software for $330. Discounts apply if you a current MUSIC version 1 user.

For further information visit the MUSIC web site at www.toolkit.net.au/music

Please note: You must be a registered Catchment Modelling Toolkit member to download the MUSIC evaluation version.

UPCOMING TECHNICAL REPORT

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

By
Belinda Hatt
Ana Deletic
Tim Fletcher

Technical Report 04/1

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

Printed and bound copies of this report will be available during May 2004 from the Centre Office for $27.50.

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

year flow into the system, while the larger events would simply flow over the speed hump and down the road as they did in the past. A sediment trap, sized to treat particles down to 125 um, was built preceding the bioretention system to prevent the large, easily removed particles from entering and smothering the biofiltration swale. A riser pipe with outlet orifices was installed in the basin to drain it after storms and minimise risk to the public, eg. children falling in.

The flow from the sediment trap outlet was spread over the swale to minimise resuspension and increase infiltration into the trench. The swale is kept at a slope of <4% to prevent scouring and erosion and vegetated with indigenous plants – predominately rushes and sedges. The underlying trench was filled with a sandy loam, (average particle size 0.45 mm), and 3-5 mm gravel screenings surrounding the slotted pipe in the bottom. A rock stilling pool at the end of the trench slows the flow as it enters an existing dam. The water in the dam is reused on the market gardens as well as providing habitat for microphytes that are studied by visiting school children.

Modelling performance
The expected performance of the treatment train was modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). The results in Figure 4.2 demonstrate that the Victorian Best Practice Environmental Management Guidelines for Urban Stormwater can easily be met (note log-scale).

Two CRC for Catchment Hydrology post graduate students, Dale Browne and Nilmini Siriwardene, who are researching the clogging of biofiltration systems have also visited the site and provided input regarding design elements that would be useful for monitoring. This site is also ideal as the clogging can be studied over the life of the system.

Next steps
The next challenge is to design a stormwater treatment system for a large carpark that borders the site of CERES new sustainable community centre. The centre is to be built some time in the next 2-3 years, therefore, the treatment system is required to cope with the rigours of a construction site. We'll report results of our monitoring as soon as possible!

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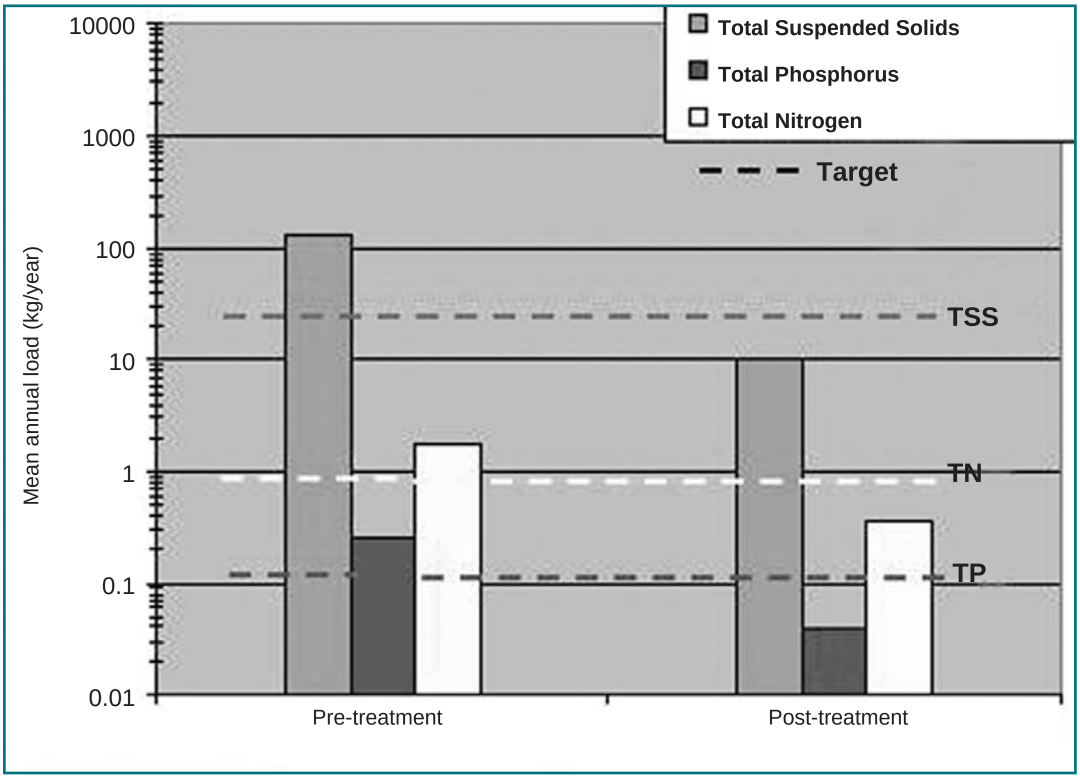

Figure 4.2. Modelled Treatment Performance of Biofiltration system

PROGRAM 5

CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Sri Srikanthan

Stochastic generation of spatial daily rainfall

Rainfall data at a number of sites over large regions are required as inputs into water system models, like IQQM and REALM, to simulate present conditions as well as changes in system behaviour as a result of changes in climate and catchment characteristics and in management practices. Climate can vary considerably from year to year, and stochastic data provides a means for quantifying the uncertainty in the hydrological system as a result of climate variability. To model a large region realistically, stochastic rainfall models must take into account the spatial dependence between rainfalls across the region.

From point rainfall to spatial rainfall

Compared to stochastic point daily rainfall models, spatial daily rainfall models are much less common. As reported in an earlier issue of *Catchword* (October 2003), the extended two-part model (Wilks, 1998) and the random cascade model (Jothityangkoon, 2000) were selected for testing. The results from the application of the extended two-part model are presented in this report.

Wilks (1998) extended the familiar two part model, consisting of a two–state, first-order Markov chain for rainfall occurrences and a mixed exponential distribution for rainfall amounts, to generate rainfall simultaneously at multiple locations by driving a collection of individual models with serially independent but spatially correlated random numbers. Individual models are fitted to each of the K sites first. The collection of individual site models are driven with vectors of uniform [0,1] variates u_t and v_t whose elements, $u_t(k)$ and $v_t(k)$ respectively, are correlated so that $\text{corr}[u_t(k), u_t(l)]$ 0 and $\text{corr}[v_t(k), v_t(l)] \neq 0$, and are serially and mutually independent $\text{corr}[u_t(k), v_t(l)] = \text{corr}[u_t(k), u_{t+1}(l)] = \text{corr}[v_t(k), v_{t+1}(l)] = 0$. Non-zero correlations among the elements of u_t and v_t result in intersite correlations between the generated rainfall sequences.

Application in catchments

The model has been applied to two focus catchments. Twenty rainfall stations were selected in the Yarra focus catchment and separate two part modes were fitted to the twenty sites. The spatial correlation between the pairs of stations for rainfall occurrences and rainfall amounts were calculated. These correlations were used to obtain uniform random variates with the appropriate spatial correlations.

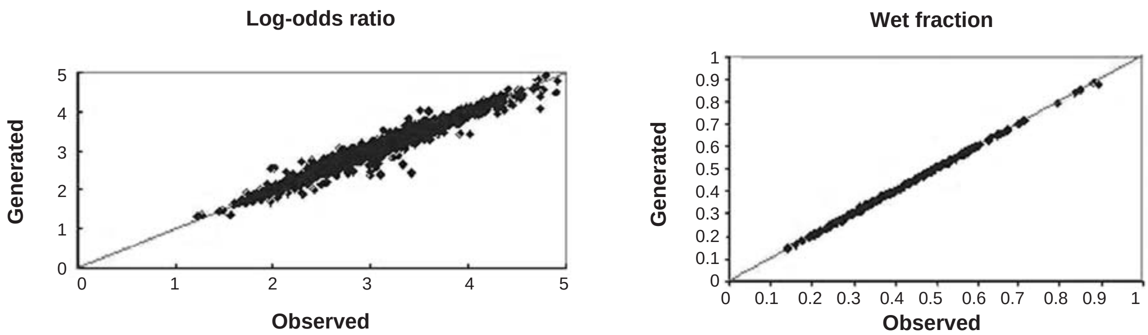

Figure 5.1 Comparison of log-odds ratio and wet fraction for Yarra catchment

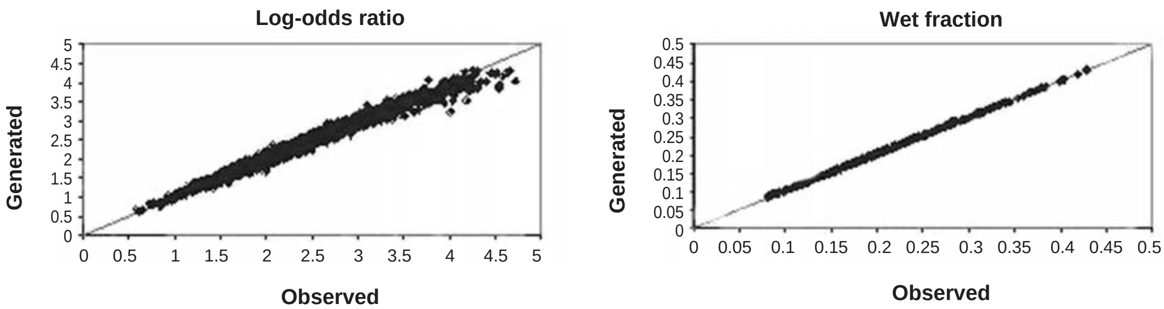

Figure 5.2 Comparison of log-odds ratio and wet fraction for Murrumbidgee catchment

NEW TECHNICAL REPORT

Non-Structural Stormwater Quality Best Management Practices - Guidelines for Monitoring and Evaluation

By

André Taylor
Tony Wong

Technical Report 03/14

This report presents a new evaluation framework and guidance for measuring the effects and life-cycle costs of non-structural best management practices. This framework defines seven different styles of evaluation to suit the needs and budgets of a variety of stakeholders involved with stormwater management.

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RECENT TECHNICAL REPORT

Stochastic Generation of Climate Data

By
Ratnasingham Srikanthan
Senlin Zhou

Technical Report 03/12

This report describes stochastic climate data generation models for the generation of annual, monthly and daily climate data (rainfall, potential evapotranspiration, maximum temperature and other variables) that preserves the correlation between the different variables. The performance of the models are evaluated using climate data from ten sites located in various parts of Australia.

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The spatial correlation between pairs of sites is assessed using log-odds ratio, which is defined as

$$lor(i,j) = \log \frac{p_{00}(i,j)p_{11}(i,j)}{p_{01}(i,j)p_{10}(i,j)}$$

where lor(i,j) is the log-odds ratio between raingauges i and j, p00(i,j), p11(i,j), p00(i,j) and p00(i,j) are the joint probabilities of no rain at both stations, rain at both stations, no rain at station i and rain at station j, and rain at station i and no rain at station j respectively. Also, the wet fraction at each is compared to see whether the at-site characteristics are also preserved. The log-odds ratio and the wet fraction for the Yarra catchment are shown in Figure 5.1.

Thirty rainfall stations were used in the Murrumbidgee catchments, which are the same data set used by the CSIRO Land and Water in their study (obtained from CSIRO Land and Water). The log-odds ratio and wet fraction for this catchment are shown in Figure 5.2.

Model performance

It can be seen from these figures that the model satisfactorily models the rainfall occurrences in both the catchments. Work is in progress to generate the rainfall amounts on wet days and results will be reported later in a CRC for Catchment Hydrology Technical report.

References:

Jothityangkoon, C., Sivapalan, M. and Viney, N. R. 2000. Tests of a space-time model of daily rainfall in sqouthwestern Australia based on nonhomogeneous random cascades. Water Resources Research, Vol. 36(1): 267-284.

Wilks, D. S. 1998. Multisite generalisation of a daily stochastic precipitation generation model. Journal of Hydrology 210: 178-191.

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PROGRAM 6

RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by Geoff Vietz

Linking River Hydrology and Morphology: In-Channel Benches

Benches are found almost everywhere in Australian river channels. They affect flood conveyance and low flow hydraulics. They can be a substantial in-channel store of sediment. They are also thought to have an important role in river ecosystems for nutrient dynamics including oxygenation, decomposition and denitrification, regulation of species composition and the distribution of flora and fauna (Junk *et al.* 1989). Understanding the distribution of benches, the variation in their form, and processes of bench formation and destruction, will contribute to river and catchment management.

As part of the River Restoration program, in Project 6.06 (6B), my PhD addresses this knowledge gap. A key focus is to identify the flow components of a river system which are predominantly responsible for creation and destruction of benches: this will be particularly important for environmental flow allocation. To reach this goal, a definitive classification of benches and bench types was compiled; this article provides a brief review.

Why is a 'bench' not a 'bar'?

The term bench has been applied inconsistently. To avoid confusion it is suggested that a useful definition of a bench is a bank-attached planar sediment deposit that represents the current flow regime and occurs at elevations between the river bed and the floodplain. Bars are strictly excluded in this definition because they form part of the channel bed. To further clarify the distinction between bars and benches, a series of process-based distinctions has been developed:

- the dominant mechanism for aggradation of benches is vertical accretion compared with lateral accretion for bars;
- benches are predominantly the result of suspended-load deposition – fine grained sediment (Woodyer 1968) compared with predominantly bed-load deposition - courser sediment for bars (Woodyer, Taylor et al. 1979);
- bench accretion is in the form of tabular sets rather than trough sets (Nanson and Page 1983);
- benches exhibit a gradual downstream longitudinal slope compared with a gradual upstream slope for bars.

The most important component of bench formation is the hydraulic conditions which lead to velocity reduction and subsequent deposition of fine sediment. The reduction in velocity is commonly the result of separation of flow from the main channel and reverse flows, i.e. an

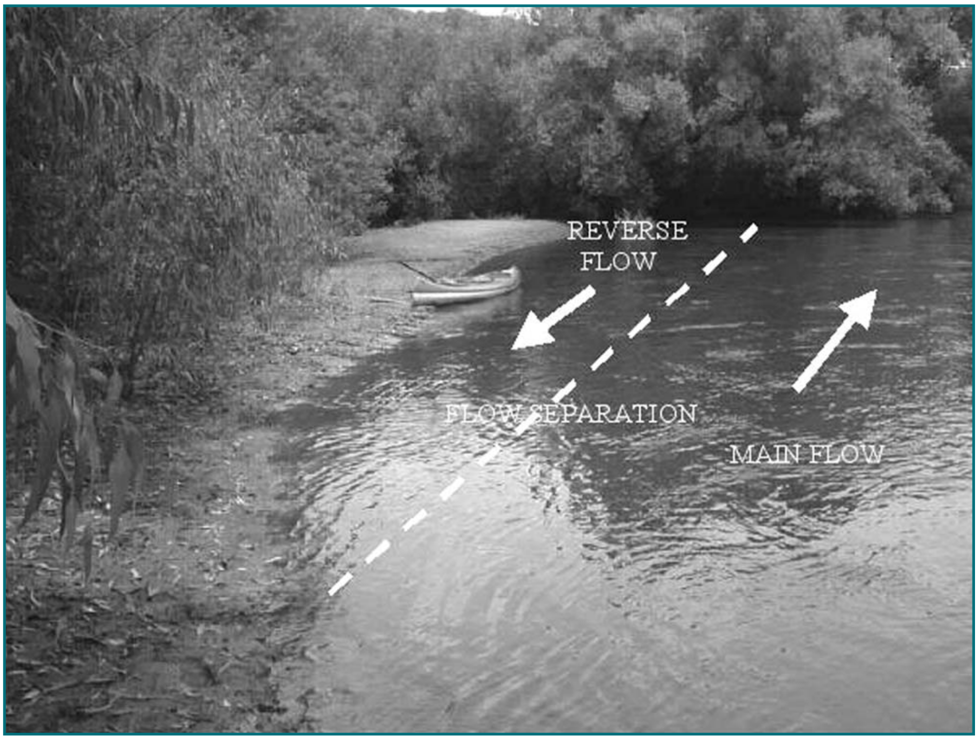

Figure 6.1. 'Concave Bench' on the Ovens River, northeast Victoria.

NEW TECHNICAL REPORT

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

By
Jo Chong

Technical Report 03/2

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

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

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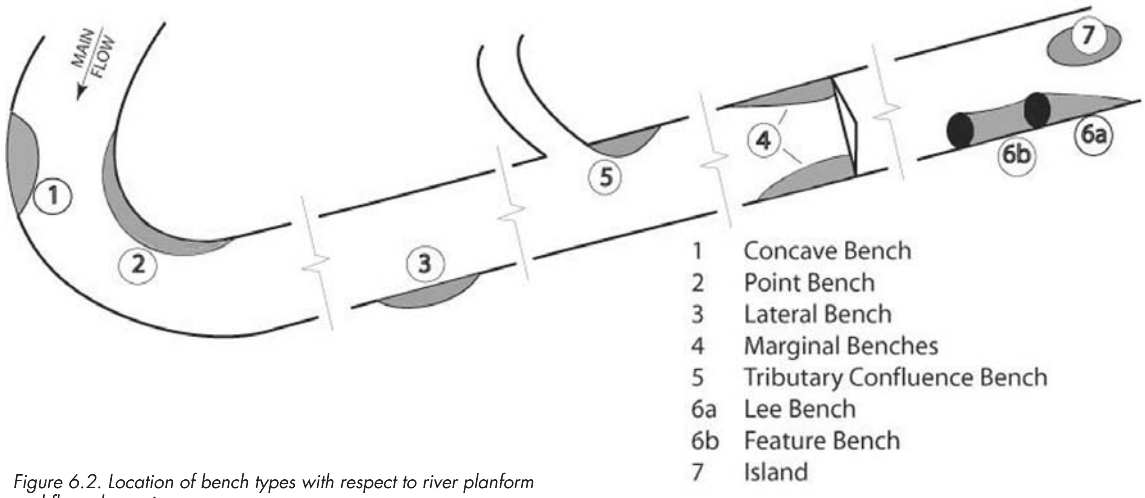

Figure 6.2. Location of bench types with respect to river planform and flow obstructions.

eddy, Figure 6.1. There is some overlap of processes which form benches and bars, which adds to the difficulty in distinguishing between these features.

Bench Types

Currently no comprehensive classification of benches is available in the literature so a classification scheme has been developed as an initial stage in the study. The classification is based on a review of literature and observation and identifies seven types of benches, classified according to location relative to river planform and flow obstructions, as in Figure 6.2.

For each bench type, a particular flow can have differing impacts on the rate of formation and frequency of destruction. By investigating bench types in isolation, a better understanding can be gained. By applying this classification to the Buckland River, northeast Victoria, numerous bench types were identified within a section of several kilometres.

Flow Components for Bench Formation and Destruction

Generally, two groups of flow events are believed to be responsible for bench evolution:

- small to medium sized floods which deposit sediment and construct benches
- catastrophic floods which lead to bench destruction (Erskine and Livingstone 1999).

This has obvious implications for regulation of rivers, and the subsequent loss of the compound channel form, or benches, that characterise many of south-east Australia's rivers.

This investigation will pursue benches at various catchment scales. Catchment characteristics, particularly hydrology, that result in the bench form will be identified. Reach-scale variation will be tested. At the bench scale, stratigraphic analysis will allow rates of formation to be identified and flow components to be linked using definable layers such as those resulting from upstream fires. These results are of course dependent on ambition not outweighing potential.

This investigation is inspired by the current trend of linking hydrologic components to river morphology. In particular, flow allocation is commonly provided for the inundation of benches: numerous ecological benefits have been associated with this. Definition and classification of benches initiates an increased understanding. The aims of this investigation are to identify the key flow components that form, maintain and destroy benches. The understanding of the flow components for bench formation may assist in appropriate river rehabilitation design and scientifically justifiable environmental flow recommendations. Management aimed at enhancement of compound channel form may assist in maximising stream health.

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NEW TECHNICAL REPORT

Stochastic Models for Generating Annual, Monthly and Daily Rainfall and Climate Data at a Site

By
Ratnasingham Srikanthan
Senlin Zhou

Technical Report 03/16

One of the goals of the Climate Variability Program in the Cooperative Research Centre (CRC) for Catchment Hydrology is to develop computer programs for generating stochastic data at time scales from less than one hour to one year and for point sites to large catchments.

The first phase of the program (2000-2002) has developed models to stochastically generate rainfall and climate data for a site at annual, monthly and daily time scales. Different models have been tested using data from across Australia, and the results have been reported in a series of CRC for Catchment Hydrology reports and research papers.

The purpose of this report is to provide guidance on the use of the stochastic modelling software.

Printed and bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

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COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect – May 2004

At a glance – a summary of this article

This month's article draws on some basic principles from the marketing discipline. Whilst the marketing has developed in a commercial business context, it can be useful for nonprofit organisations (such as the CRC) to assess their performance from a 'customer' perspective. The marketing concept of value and its importance is discussed.

Staying in business

"An organisation exists to deliver value to shareholders. To survive, all organisations must deliver value to their customers". These statements were made at a lecture I attended earlier this year. They were obviously made with a commercial business perspective in mind. *Catchword* readers will appreciate that in the business world, an organisation that does not promise and/or deliver value to its shareholders through share price gains or dividends will not be around for long. Similarly a company that does not deliver value to its customers does not stay in business; they will not have a market for their product or service.

Whilst the CRC for Catchment Hydrology is not a commercial business, these statements are still worthy of consideration from our perspective. If we substitute 'shareholders' with 'research and industry Parties' the statement offers a useful viewpoint. The research and industry organisations that form the CRC have invested with the expectation of a significant return; return in the advancement of understanding and an increased ability to manage complex land and water issues. To be a successful CRC, we also have to deliver value to our 'customers' or users – those people who apply our knowledge and products in the land and water management industry. Not surprisingly, many of our individual 'customers' belong to the organisations that form the shareholders of the CRC (Parties), but there are also many others who are part of organisations not formally connected to the CRC.

The concept of 'value'

If we accept the business world analogy then we must ask ourselves "what is value" in our context? Broadly, value is defined as a ratio between what the customer gives and what they receive.

i.e. $\text{Value} = \frac{\text{Benefits}}{\text{Costs}}$

I'm sure this model rings true with *Catchword* readers, all of whom no doubt at some point have analysed the pros and cons of an important purchase to determine whether there is enough value in the exchange of their money for a product they desire. Cars are a good example because manufacturers try to entice you with extra accessories for an additional cost above the price of the basic car; 'are these extras worth the additional cost?' At some point the answer will be 'no', and for that particular car buyer, that's the point where the costs outweigh the benefits – they stop investing.

Benefits and costs

In the definition above the benefits are defined by marketers as an attribute(s) of the product or service 'desirable to the customer as perceived by the customer'. This last aspect is very important. It's not profitable to add a feature to a product if the customer doesn't see it as an additional benefit. Further the notion of price is defined as the 'total costs to the customer'. Costs can be monetary but can also be time, energy and psychic (mental effort, frustration etc). It is these costs that are often the most important to a nonprofit 'business'. For example, if the CRC produces some catchment modelling software that has significant costs in time and energy (e.g. learning the software and obtaining the data) that outweigh the perceived benefits of the product, then it is not likely to be applied regardless of the monetary cost. The challenge for organisations such as our CRC that seek adoption rather than profit is to reduce these costs as much as possible through training, user assistance and supporting materials. Equally, to encourage adoption, creating a product that incorporates a range of effective and useful features from the user's perspective will increase the relative benefits. The simplest way to determine what these additional features should be is to ask the users and then develop the product or service from their perspective and with their assistance.

Assessing value

The marketing literature also offers typical criteria that people often use to assess value: security, performance, aesthetics, convenience, economy and reliability. Each of these criteria are just as applicable to a nonprofit organisation's deliverables. Whilst in the case of a new car the potential customer might consider security and the features built into the car to reduce theft for example, in the case of knowledge, security can be thought of in terms of reassurance to the user that the knowledge is derived from an expert source. Similarly, aesthetics may also be a critical element that contributes to adoption. The way information is presented, the user interface design, or the consistency of interfaces in a catchment model may affect a user's perception of value. The other criteria listed above offer similar insights.

Perspectives for the CRC

Whilst I'm sure it is possible to extend the application of commercially based marketing principles too far in the context of nonprofit organisations, I believe it can provide a useful perspective for assessing the way they create, communicate and deliver value to their customers. I am currently using this standpoint to review the products and activities of the CRC to ensure that our delivery is as user focused and valuable to our 'shareholders' as possible.

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RECENT TECHNICAL REPORT

Calibrations of the AWBM for Use on Ungauged Catchments

By

Walter Boughton
Francis Chiew

Technical Report 03/15

This report presents an approach for using the daily rainfall-runoff model, AWBM, to estimate runoff in ungauged catchments.

The report describes computer programs that can be used to optimise three key parameters in AWBM against runoff data from gauged catchments, and provides calibrated parameter values and catchment characteristics for 221 Australian catchments. The report then recommends an approach for using the calibrated parameter values in these and other catchments to guide the choice of AWBM parameter values for use in ungauged catchments.

Printed and bound copies of this report are available from the Centre Office for $27.50. Contact Virginia Verrelli on 03 9905 2704 or email crcch@eng.monash.edu.au

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

POSTGRADUATES AND THEIR PROJECTS

Mark Bayley

Raised by a mother who loved the bush, a father who has always worked for the water industry, and growing up down the road from Silvan Reservoir in Victoria, it seems that I have taken a fairly predictable path in my career. Not me.

I often ask myself, "how did I end up doing a PhD in Brisbane?" This question is quite hard for me to answer, and I think I have given up trying… The start of my 'academic' career began in the January of 1999 when I packed up my EH station wagon with all my belongings (surfboard, didgeridoos, sleeping bag and a few clothes) and hit the highway. Destined for Lismore, in Northern NSW. I am not too sure why I chose to go to university in Lismore, maybe the beach nearby? maybe the sub-tropical climate? maybe the huge distance between where I grew up and where I was about to live?

Two years into my undergraduate degree I was what you would call an average student. I was passing all my subjects and enjoying life and the freedom that the North Coast of NSW offers you. It was when my yet-to-be honours supervisor and life mentor Leigh Davison first introduced me to the use of constructed wetlands to remove pollutants from wastewaters. Wow I thought. From that point on, I was ingrossed with the whole concept of constructed wetlands for polluted water treatment. When I say the whole concept, I am referring to the biology and geochemistry behind how they work, the engineering and building of them, and most of all, the philosophy involved. I began researching the use of subsurface flow wetlands for the treatment of domestic wastewater for my honours project. This was an extremely busy and exciting year, which took me around Australia and the world presenting my research.

It was when I was in Arusha, Tanzania that I met Margaret Greenway. At that point, Margaret was someone I had to thank for giving me a '1st Class' grading for my honours thesis. Upon having lunch together, Margaret was quick to offer me a PhD opportunity up in Brisbane researching stormwater treatment using constructed free water surface flow wetlands. However, I had Africa to travel for two months, so I had to get back to her…..

I was in a dilemma. Move from the North Coast of NSW to Brisbane, a city, to pursue a PhD or surf, drink coffee and hang around Lennox Head until a job pops up? Well I had to move to Brisbane. The opportunity was too good to refuse.

So here I am. Doing a PhD under Margaret Greenway, Peter Pollard and Graham Jenkins at Griffith University. My research topic was determined within the initial six months of my PhD. But like all PhD's, its an ever changing and developing topic. As it stands now, I am researching 'removal processes of nitrogen, carbon and phosphorus within stormwater treatment wetlands'. I have decided to pay particular attention to post flood and inter-event periods in my studies to draw a picture on what actually happens to nutrients once they enter a wetland or pond system. Particular areas of focus include phytoplankton nutrient uptake and productivity, bacterioplankton productivity, nutrient fluxes between the sediment/water interface, pelagic nutrient processing, periphyton nutrient uptake and an overall system evaluation of nutrient removal from stormwater by constructed wetlands and ponds. My main study site is Bridgewater Creek Wetland.

That's a little bit about me. Where I have been and where I am going.

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Figure 8.1 Boating at Bridgewater Creek Wetland - insitu measurement of water chemistry parameters

CRC PROFILE

Our CRC Profile for May is:

Ana Deletic

Ana Deletic came to Australia with her husband and two children in January 2003 to take up a position as Senior Lecturer in Water Engineering at Monash University.

Prior to that, Ana had been doing research and lecturing in Environmental Engineering at the University of Aberdeen, Scotland where she also gained a PhD. Her thesis was entitled 'Sediment behaviour in overland flow over grassed areas'.

A native of Yugoslavia, Ana completed her undergraduate civil engineering degree and an MSc in Environmental Engineering and Hydraulics at the University of Belgrade. While at the University of Belgrade during and following her part-time masters course, Ana assisted with teaching and research in the Department of Hydraulic Engineering.

Since moving to Monash University, with her colleagues Ana has attracted funding of $1.5 million to conduct research in urban stormwater modelling, treatment, and re-use. She is one of the leaders of a Vic EPA Grant entitled 'Characterising Stormwater Quality in Relation to Land Use' to conduct large scale monitoring of stormwater in Melbourne. She has initiated research into re-use of stormwater at Monash, attracting two grants from NSW and Victorian EPAs.

Ana was awarded an ARC Discovery grant for 2004 - a large scale study of the clogging phenomena in stormwater treatment systems. Ana is also working on similar issues within CRC for Catchment Hydrology. She is a principal founder of the Faculty of Engineering's Institute for Sustainable Water Resources Management.

Ana is a part of the working group of the UNESCO Urban Water Data Management IHP VI project. She is one of two Australian members of the Committee of Sewer Systems and Processes Working Group, which is a joint specialist working group of the International Water Association (IWA) and the International Association of Hydraulic Research (IAHR).

Before she came to Australia, Ana was an academic member of the working party on Sustainable Urban Drainage in Scotland, set up by the Scottish Environmental Protection Agency and Water Authorities. Ana has published over forty scientific papers and book chapters.

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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 Infrastructure, Planning and Natural Resources
Department of Sustainability and Environment, Vic
Goulburn-Murray Water
Griffith University
Melbourne Water
Monash University
Murray-Darling Basin Commission
Natural Resources, Mines and Energy, Qld
Southern Rural Water
The University of Melbourne
Wimmera Mallee Water

Associates:
Water Corporation of Western Australia

Research Affiliates:
Australian National University
National Institute of Water and Atmospheric Research, New Zealand
Sustainable Water Resources Research Centre, Republic of Korea
University of New South Wales

Industry Affiliates:
Earth Tech
Ecological Engineering
Sinclair Knight Merz
WBM