NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 111 NOVEMBER 2002

A NOTE FROM THE DIRECTOR

Professor Rob Vertessy

Inside...

Program Roundup

- Updates on research projects 2-17
- Communication and Adoption Program 18

Postgraduates and their Projects
Debbie Woods 20

CRC Profile
Susan Cuddy 21

Where are they now?
John Marsh 23

COOPERATIVE RESEARCH CENTRE FOR

CATCHMENT HYDROLOGY

A NEW RESEARCH PORTFOLIO

As I write this note, we are putting the final touches to the CRC's 2003-2006 research portfolio. Included in this are detailed project agreements (essentially contracts) for fifteen research projects (spread across our six research programs), five development projects (one for each of our focus catchments), and two support projects (Communication & Adoption and Education & Training). This portfolio is being presented to the CRC Governing Board for approval on November 18. Subject to resources availability, my expectation is that most of the projects will be ready to start in early January, 2003. I'd like to pay tribute to the Program Leaders, Project Leaders and Focus Catchment Coordinators who have toiled relentlessly through the year to get us to where we are now. The retiring Director (Prof. Russell Mein), the Deputy Directors and the CRC Governing Board have also played a vital part, so my thanks go to them also. It has been an amazing team effort.

In this issue of *Catchword*, I'd like to share with you some of the considerations that underpinned the development of our new research portfolio. They are the essential ingredients to what I regard as a most impressive set of projects.

Our chief consideration was to develop a portfolio that addressed the 'three pillars' outlined in our 1998 Business Plan. The first of these was a promise to develop a capacity to predict, at whole-of-catchment scale, the consequences of land use change, climate variability and river management. The second was to ensure that this predictive capacity is 'integrated', such that an holistic analysis of catchment response and management trade-offs is made possible. The third was a promise to deliver that capacity to land and water managers. In my estimation, our new research portfolio tackles these three pillars in a systematic and effective way, putting us in very good stead to succeed by 2006.

The key to success in any R&D plan is a clear vision of what you are aiming for. Early on in our project planning process we specified a 'target modelling capability' and this has since served as our common purpose. Our fifteen research teams know exactly what we are aiming at and their individual projects have been designed to deliver a particular part of that target modelling capability. Because they are mostly oriented towards the development of models that must ultimately mesh together, each of the teams has given careful consideration to issues such as spatial and temporal scales for their models, the level of model complexity, the coding language to be used and the phasing of outputs over the next three years. Our 'Integration Team' (Project 1B) and 'Toolkit Team' (Project 1A) have been assembled to tie it all together. Both teams have already played a pivotal role in helping to get the other project teams pulling together to address our common purpose.

Then there is the third pillar; delivery of the target modelling capability to land and water managers. We have re-focussed and strengthened our Communication & Adoption, and Education & Training Programs and persuaded all of the research teams to commit heavily to 'delivery' activities. This reaffirmation is backed up by what I regard as our best innovation yet: Development Projects. We propose to run a Development Project in each of the five focus catchments. The intent of these is to build modelling capacity within our industry Parties, to obtain end-user feedback, and to operationalise the tools such that they can be applied elsewhere by the industry parties. To my delight, the industry Parties have invested significant, additional resources into the Development Projects. This kind of 'technology pull' is a vital step towards successful adoption of our research and development outputs.

It's one thing to conceive a great R&D plan, but it is quite another to ensure that each of the fourteen organisations in our CRC play a satisfying role within it. Our CRC is blessed with a long track record of Party harmony, so we started from a solid base. Still, a lot of careful planning and mountains of communication had to be done to make sure that this goodwill continues. Over half our resources are tagged to 'in-kind' contributions from the Parties, so the new projects had to be designed in such a way that all of Parties could contribute meaningfully to them. In my estimation, our Program Leaders, Project Leaders and senior Party representatives have done a great job in 'plugging in' each of our Parties into our grand plan.

I'll conclude by providing a list of the projects that are being presented to the Governing Board for approval on November 18. In future issues of *Catchword*, the Program Leaders will tell you all about them.

NEW TECHNICAL REPORT

THE STATUS OF CATCHMENT MODELLING IN AUSTRALIA

by

Frances Marston
Robert Argent
Rob Vertessy
Susan Cuddy
Joel Rahman

Technical 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

Research projects

1A - Implementation of the Catchment Modelling Toolkit
1B - Methods for integration in catchment prediction
2A - Reducing the impacts of irrigation and drainage on river water salinity
2B - Improved suspended sediment and nutrient modelling through river networks
2C - Predicting salt movement in catchments
2D - Modelling and managing nitrogen in riparian zones to improve water quality
2E - Modulating daily flow duration curves to reflect the impact of land-use change
3A - Hydrologic and economic modelling for water allocation
3B - An evaluation of permanent water markets
4A - Development of integrated stormwater models
4B - Predicting urban stormwater quality, treatment and impacts
5A - Hydrological modelling for weather forecasting
5B - Stochastic rainfall data generation models
6A - Development of flow-ecological response models
6B - Predicting spatial and temporal variations in channel form

Development Projects

7A - Modelling and managing land-use impacts in and around water storages in northern Victoria
7B - Modelling sediments and nutrients in the Murrumbidgee Catchment to inform investment
7C - Modelling river water quality in the Yarra Catchment
7E - Modelling river water quality in South East Queensland in partnership with catchment groups
7F - Modelling river water quality in the Fitzroy Catchment in partnership with regional strategy groups

Support Projects

7G - Communication and Adoption
8A - Education and Training

Rob Vertessy
Tel: (02) 6246 5790
Email: rob.vertessy@csiro.au

PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
GEOFF PODGER

Catchment Modelling Toolkit and the website

David Perry and I recently reviewed a communication and adoption strategic issues paper that he had produced. The aim was to look at strategies to deal with a host of issues that had been raised with respect to the delivery of the CRC's Catchment Modelling Toolkit. Some of the issues that we considered included:

- making people aware of our products,
- marketing and distribution,
- licensing and intellectual property,
- product documentation, upgrades and support,
- design of the website (style, common look and feel), and
- ensuring long term commitment to the concept.

We agreed that an effective way of dealing with these issues is to develop a web based delivery system. The web is easily accessible by the types of users that would want to use our products and, designed appropriately, could operate with a minimum amount of effort and cost. The web also provides a means of rapidly delivering information and products to users throughout Australia and internationally.

Toolkit Assistant

Over the next three years the CRC for Catchment Hydrology will produce a large number of new software and data products applicable to a broad range of catchment management problems. So that people can find out about these products we will provide appropriate tools to be able to search the Toolkit site. One idea that we had is to provide a 'Toolkit Assistant' that would help guide people to the appropriate products. This could provide advice on how the CRC's catchment modelling products may be linked together and what data they require. In some cases there will be off-the-shelf products and in other cases a purpose built model may be required to meet the user's objective.

When a registered user has selected an appropriate product(s), they will be able to download either a trial version of the software or the full version (for free or at cost, depending on the particular product). Before using the product, the user will be required to agree to a licensing agreement. In some cases due to size, the software or data product may need to be sent to the user on CD.

Product licensing

Toolkit products may have different licensing agreements depending on who owns the intellectual property rights for the product. There may also be different types of license agreements depending on the type of user for example, students, industry partners, commercial users (consultants etc) and research collaborators contributing models from outside the CRC. Rob Vertessy, Susan Cuddy, John Molloy and Fred van Dijk met recently to develop a set of appropriate licensing agreements.

Licensed users will be able to access the web at any time to download the latest upgrades and documentation, and to participate in user group discussions. The licensed user will also be offered two types of email support. Firstly, the product manager will send regular information about product updates to registered users and secondly there will be user forums set up for each product whereby other users and product managers can answer questions.

How the website will look

With the help of Daniel Figucio and Frances Marston, we are planning the functionality and look and feel of the Toolkit website. A possible opening screen for (Integrative Component Modelling System (ICMS) is shown in Figure 1.1. We are considering the ease of use and the practicalities of downloading files of different sizes. We will employ a graphic and web designer next year to assist with the development of the site to ensure it meets users needs. We will continue with the common theme of the Toolkit jigsaw puzzle piece throughout the site.

Maintaining the website

The website will deal with the dissemination of information and products to the relevant people. We are confident that an initial version of the website will be operational by June 2003 or earlier, replacing the current site at www.catchment.crc.org.au/toolkit. The new site will allow users access to existing CRC for Catchment Hydrology software and some recently developed over the first round of CRC projects. This will give us a way of testing the site and getting valuable feedback from users.

Geoff Podger
Tel: (02) 9895 7480
Email: gpodger@dlwc.nsw.gov.au

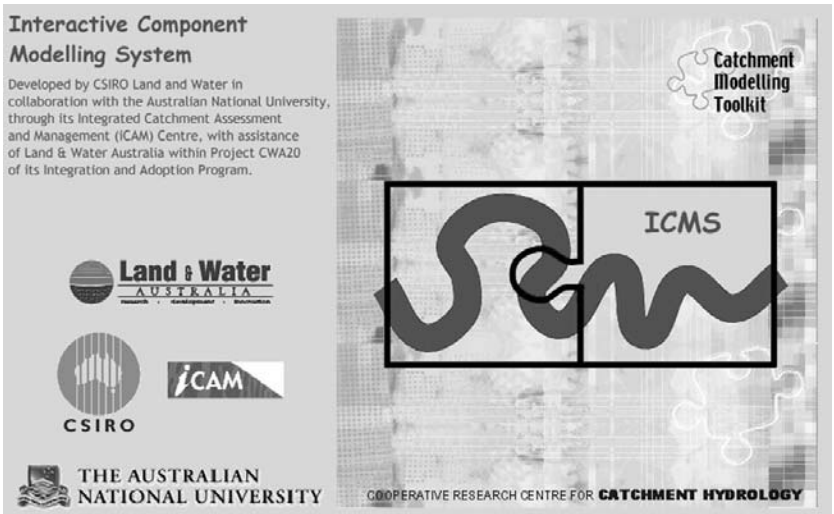

Figure 1.1 Website opening screen

RECENT TECHNICAL REPORT

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

by

Francis Chiew
Philip Scanlon
Rob Vertessy
Fred Watson

Technical 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.

RECENT TECHNICAL REPORT

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

by

Francis Chiew
Philip Scanlon

Technical Report 02/2

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

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

Copies are available through the Centre Office for $27.50

For further information contact the Centre Office on 03 9905 2704

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Heather Hunter

Nutrient management issues for water quality protection in sugar cane catchments

Background

Land use and land management activities are widely recognised as contributing to downstream water quality problems in many catchments. These topics are now the focus of major initiatives such as the National Action Plan for Salinity and Water Quality and the Great Barrier Reef Catchment Water Quality Action Plan. To support these activities, there is considerable demand for the development and use of predictive models at a range of scales to better understand the processes involved and their implications for water quality management.

This article provides a brief overview of a recently completed project, which gave some insights into the complexities and challenges that exist in developing relationships between land management actions and their downstream effects on water quality. The project was conducted between 1997 and 2001, with a focus on quantifying the movement of sediment, pesticides and nutrients (nitrogen and phosphorus) from sugar cane lands to nearby waterways and groundwater. Impacts on downstream water quality were assessed, together with the implications for land management. Nutrients only are considered in the following brief discussion.

Overview of study sites

Study sites were located in Australia and Mauritius. The Australian study sites were in the Gregory and Isis River catchments south of Bundaberg, and the Cattle Creek catchment on the Atherton Tableland. Crop management practices and climate at the Gregory and Isis catchment sites were similar, but soil types, topography and drainage patterns differed. Soils, climate and crop management in the Cattle Creek catchment all differed from those in the Bundaberg area. In particular, the crop in the Cattle Creek catchment was predominantly flood irrigated, with runoff draining to nearby watercourses, whereas overhead spray irrigation was practiced at the other Australian sites. The study site in Mauritius was on permeable soils on higher slopes in a high rainfall environment, conditions very similar to those found in the Johnstone River catchment in north Queensland.

The Gregory catchment site was instrumented to measure agrochemical transport at a range of nested scales, from small on-farm plots to the catchment of Wallum Creek (790 ha). Intensive sampling was carried out at the different scales during runoff events, while base flow in Wallum Creek was also monitored between events. Periodic monitoring of piezometers provided information on nutrients in shallow groundwater. The study site in Mauritius was similarly instrumented, while the other Australian study sites were monitored less intensively. In both countries broader scale monitoring of stream water quality was also conducted. Analysis of water samples included measurement of the various dissolved and particulate forms of nitrogen and phosphorus.

Key research findings

All sites received average to below-average rainfall over the course of the study and the nutrient losses measured were relatively small from a farm production viewpoint (as in Figure 2.1). At the Gregory catchment site, nutrient exports in runoff were comparable with inputs in rainfall and irrigation water (see also Figure 2.1).

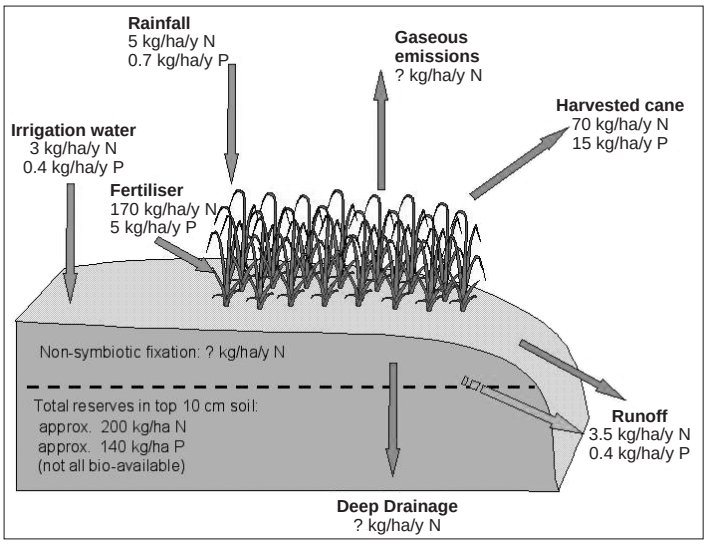

Figure 2.1 Approximate nutrient budget for sugar cane grown at the Gregory catchment site. Note that data were not available for some possible loss pathways.

Nevertheless, in some cases adverse impacts on downstream water quality were observed, with the effects differing markedly between sites. Thus, no generalisations can be drawn on the impacts of sugar cane farming on stream nutrient loadings and case-by-case assessments are required, based on an understanding of the key factors and processes involved. Findings were:

- No major issues were identified in the Gregory catchment, where gradients were relatively low and soils predominantly had restricted subsurface drainage. Farm runoff and drainage was channelled along grassed waterways and drains, entering Wallum Creek through an extensive buffer of riparian vegetation. Stream nutrient concentrations were generally considered unlikely to pose a threat to ecosystem health, although there could be some longer-term risks from sediment and associated nutrients deposited along stream channels during runoff events.
- By contrast, consistently high stream concentrations of nitrate were found at the nearby Isis catchment site (Figure 2.2), which were attributed to the presence of higher slopes and permeable soils underlain by a confining layer that directed drainage towards the stream. Nitrate concentrations were well above recommended guideline levels for the protection of aquatic ecosystems.
- Very high nitrogen and phosphorus concentrations were found in Cattle Creek during the latter part of each year (Figure 2.3), accompanied by very low dissolved oxygen levels. Concentrations of both nitrogen and phosphorus at these times were much higher than found at other sites and greatly exceeded respective guideline levels for protection of aquatic ecosystems. This indicates a priority need for better fertiliser and irrigation tail-water management during these months.

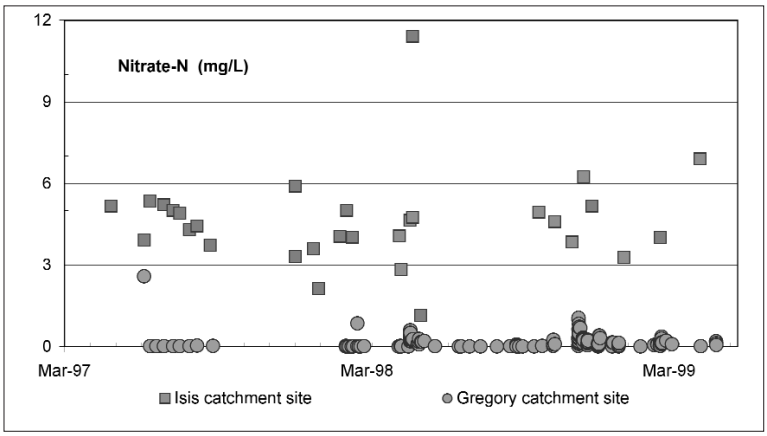

Figure 2.2 Comparisons of nitrate concentrations in small streams in two sugar cane growing catchments near Bundaberg in southern Queensland. Note that the recommended guideline level for protection of slightly disturbed aquatic ecosystems in sub-tropical Queensland is 0.06 mg/L nitrate-N.

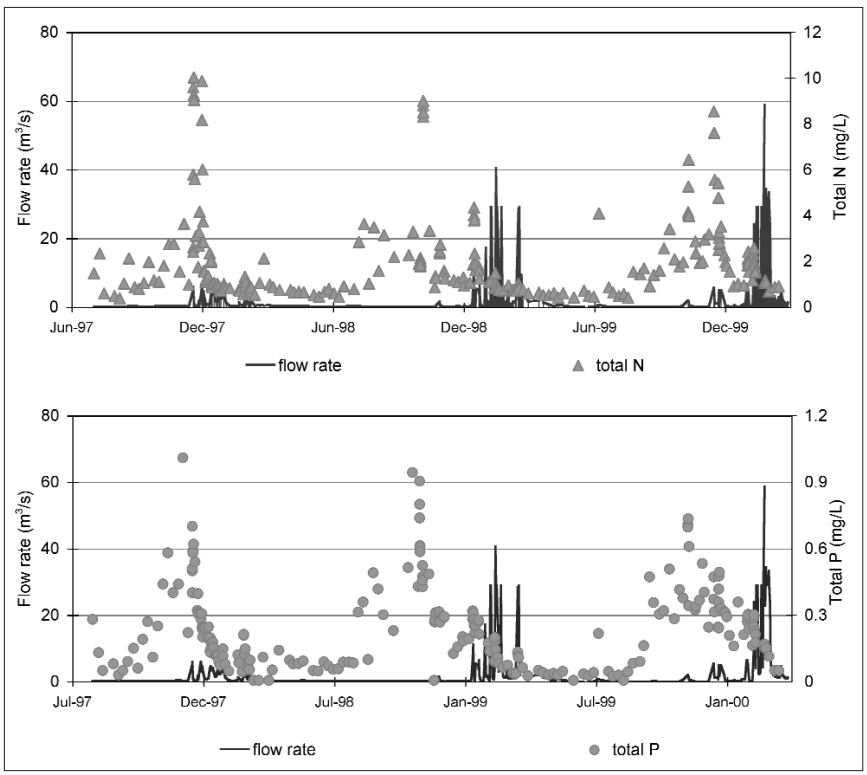

Figure 2.3 Seasonal fluctuations in concentrations of; a) total nitrogen; and b) total phosphorus in Cattle Creek. Recommended guidelines for protection of slightly disturbed ecosystems in tropical upland streams are 0.15 mg/L total N, and 0.01 mg/L total P.

RECENT TECHNICAL REPORT

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

by

Iain Hume
Tim McVicar
Michael Roderick

Technical Report 02/3

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

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

Copies are available through the Centre Office for $27.50

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

- Priorities for nutrient management in Mauritius were similar to those identified in a previous study for the Johnstone catchment in Queensland. There was very little off-farm movement of phosphorus (apart from that associated with sediment) but downstream nitrate levels were elevated in cane-growing areas for much of the year. Stream nitrate concentrations at both locations were typically around 1 - 2 mg/L (nitrate-N), indicating a need to address fertiliser management practices and to adopt strategies for minimising the movement of nitrogen to streams.

Overall comments

The research findings can now be incorporated into 'risk management decision tools' for landholders to enhance their ability to make sound management decisions that optimise crop production and address environmental concerns. The study highlighted the diversity of downstream effects that can occur from a single land use. From a modelling viewpoint this indicates the need for models (or suites of linked models) that can discriminate between key drivers such as soil type, drainage characteristics and management practices in their prediction of downstream effects on water quality.

Acknowledgments

The study was carried out by the Queensland Department of Natural Resources & Mines (NR&M) in collaboration with the Mauritius Sugar Industry Research Institute (MSIRI), and was funded by the Australian Centre for International Agricultural Research, the Queensland Government and the MSIRI. The Cooperative Research Centre for Sustainable Sugar Production and the Bureau of Sugar Experiment Stations also provided technical and financial assistance. The study leader was Bruce Simpson (NR&M) and research in Mauritius was lead by Dr René Ng Kee Kwong (MSIRI). My thanks to Bruce, René and other colleagues involved in the study for their collective contributions to the research reported in this article; and also to Myriam Raymond for providing the illustration for Figure 2.1.

Further reading

Simpson, B.W. (2001). Editor, *Offsite movement of agrochemicals in tropical sugarcane production,* Proc. Extension Workshop, Bundaberg, Aust., 8 – 9 May, 2001, 114 pp.

Heather Hunter
Tel: (07) 3896 9637
Email: heather.hunter@nrm.qld.gov.au

CONFERENCE PROCEEDINGS

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

27-29 August 2001

Brisbane, Queensland

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

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

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

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

PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by Wijedasa Hewa Alankarage and Hector M Malano

Permanent Water Trading in the Goulburn-Murray Irrigation Scheme

Introduction

Water sector reforms were proposed by the Council of Australian Governments (COAG) in 1994, and the Murray-Darling Basin Cap was introduced in 1995 to limit water use in the basin. These reforms promote re-allocation of water as the most suitable approach to meeting new demands and preventing further deterioration of river environments. Water trading (transfers) is recognised as an appropriate tool to reallocate water resources.

Water is traded both temporarily and permanently. Temporary trading is primarily aimed at meeting seasonal demands, while permanent trading is aimed at meeting demands associated with long-term developments and new ventures. There is also a geographical dimension to water trading which may involve local, inter-valley, and inter-state water transfers.

Trends in Permanent Water Trading

Permanent water trading was first introduced in Victoria in the 1991/92 water-year and has been gradually increasing in the past ten years in Victoria. At present it amounts annually to about 1% of the total permanent entitlements attached to the Goulburn-Murray Irrigation Scheme (GMIS).

A study of the drivers for permanent water trading in irrigation areas within the Goulburn-Murray Irrigation Scheme (GMIS) was conducted in 2001. The survey results show that over 40% of permanent water entitlements were purchased to satisfy the needs of existing irrigated land. This percentage has slowly reduced in the last 10 years. Conversely, water purchases for expansion of farming enterprises and non-farming uses have been gradually increasing. Currently, purchase of permanent water entitlements for expansion of farming enterprises accounts for around 50% of total purchases.

Horticulture and dairy farming account for more than 80% of purchases of permanent water entitlements in the GMIS. The trend observed in permanent water trading from the inception of trading up to 1999/00 is shown in Figure 3.1. The region comprising Shepparton, Central Goulburn and Rochester irrigation areas, and Campaspe Irrigation District is a major importer of permanent water entitlements (denoted as Goulburn in Figure 3.1). More than 50% of land in this region is used for high value farming and more than 50% of permanent water entitlement purchases have been made from other regions. A significant proportion of permanent water entitlements have also been sold to buyers beyond the GMIS in the recent past. This is a

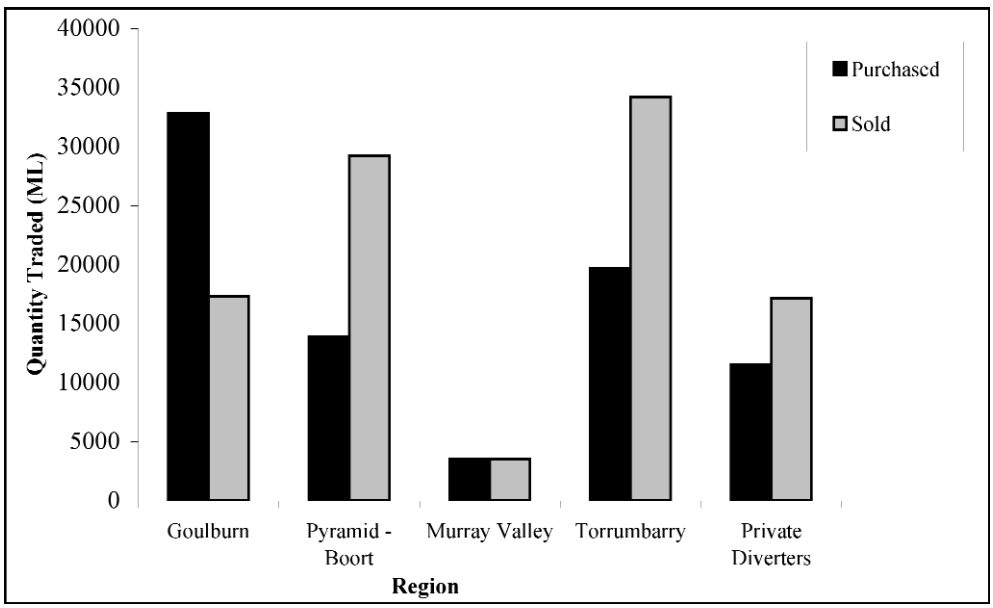

Figure 3.1. Distribution by Regions of Water Entitlements Purchased and Sold from 1992 to 2000 in the Goulburn-Murray Irrigation Scheme
(Source: Annual reports of Rural Water Commission of Victoria from 1991/92 to 1993/94, and G-MW from 1994/95 to 1997/98)

NEW TECHNICAL REPORT

THE DEVELOPMENT OF WATER REFORM IN AUSTRALIA

by
John Tisdell
John Ward
Tony Grudzinski

Technical Report 02/5

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

This report is now available from the Centre Office for $33.00.

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

NEW TECHNICAL REPORT

WATER TRADING IN THE GOULBURN-MURRAY IRRIGATION SCHEME

by

Wijedasa Hewa Alankarage
Hector Malano
Tom McMahon
Hugh Turral
Garry Smith

Technical Report 02/9

This CRC report presents the outcomes of a study of permanent and temporary water trading in irrigation areas within the Goulburn-Murray Irrigation Scheme (GMIS). The study is based on a survey of permanent and temporary water traders in the GMIS from March to May 2001 and past water records of the GMIS. Outcomes of studies in the area based on two previous surveys conducted in 1994 and 1996 and an irrigation farm census conducted in 1997 have also been compared.

This report will be published during December and will cost $27.50 including GST, postage and handling.

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

result of relaxation in restrictions for transferring permanent water entitlements out of the GMIS.

Around 50% of permanent water entitlements have been sold as a result of excess water from sleeper/dozer licences. The major source of water entitlements traded on the permanent water market for last ten years is cropping and grazing irrigators who account for 80% of permanent water entitlements sold. Pyramid-Boort, Kerang and Swan Hill areas and private river diverters are the main source of water for the permanent water market in the GMIS.

The majority of trades have taken place within irrigation areas/districts and the majority of traders surveyed have indicated no explicit preference to purchase internally or externally.

Desirable Water Availability and Permanent Water Trading

The main alternative available for farmers to restructure their water availability is to change the volume of permanent water entitlement per unit area (water availability). This study, as well as previous studies, shows that about 50% of buyers of permanent water entitlements and 40% of sellers trade their permanent water entitlements because of shortage (buyers) or excess (sellers) of water in existing irrigated areas. Consistent stocking rates and the ratio of annual pasture to perennial pasture in dairy farming have also been observed in the study area.

An analysis of water availability for three farm types – dairy, horticulture and cropping and grazing - shows that permanent water traders desire to achieve a particular level of water availability as a measure of water security, a level which is unique for each farm type. The mean values of desired water availability are 5.70 ML/ha (based only on perennial pasture) for dairy, 3.10 ML/ha for horticulture and 1.91 ML/ha for cropping and grazing farm types. These figures were compared with desired availability for the same farming enterprise groups of temporary water traders who had not traded their permanent entitlements during the period of the study (Table 3.1). Statistical tests prove that no significance difference exists between the two categories of water traders shown in Table 3.1.

The desired water availability of buyers and sellers of permanent water entitlements is sensitive to prices of farm products. The analysis shows a reduction in the level of water availability desired by farmers when farm product prices reduce. Compared with cropping and grazing, the desired water availability of dairy and horticulture farmers is more sensitive to price reductions. It also reveals that sellers of permanent water entitlement would have opted for higher water availability by retaining their water entitlements if prices of farm products had been higher. For example, cropping and grazing sellers would have maintained 1.82 ML/ha instead of 1.47 ML/ha if commodity prices had been 10% higher.

Project report

The work reported here has been carried out as part of CRC Associated Project 3.6. The work is reported in more detail in a draft CRC Technical Report (Report 02/9, October 2002) entitled "Water Trading in the Goulburn-Murray Irrigation Scheme".

Wijedasa Hewa Alankarage
Tel: (03) 8344 4709
Email: h.wijedasa@civag.unimelb.edu.au

Hector M Malano
Tel: (03) 8344 6645
Email: hectormm@unimelb.edu.au

Table3. 1. Comparison of Water Entitlement per Unit Area of Permanent and Temporary Water Traders

Farm type	Mean Water Entitlement per unit area (ML/ha)	
	Permanent transfers	Temporary transfers
Dairy - based on total irrigated area	3.86	3.72
Dairy - based on perennial pasture area	5.69	5.71
Horticulture	3.08	3.14
Cropping and grazing	1.87	1.92

PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader
TIM FLETCHER

Report by Margaret Greenway

Bioretention Systems for Urban Stormwater Management and Landscape Amenity

Sediment and nutrient control

Urban stormwater best management practice is aimed at improving the quality of urban runoff prior to discharge into natural waterways, thereby reducing potential downstream impacts on aquatic ecosystem health.

A number of stormwater treatment devices are currently used for sediment and nutrient control:

- Gross pollutant traps (to catch coarse sediment and trash)
- sediment basins (to capture coarse and fine sediment)
- vegetation buffer strips (sediment and nutrient removal by sheet flow across wide natural vegetation strips)
- infiltration and bioretention systems (sediment and nutrient removal by filtration and biological processes)
- vegetated swales (sediment and nutrient removal along concentrated flow paths)
- ponds & wetlands (sediment and nutrient removal by aquatic ecosystems dominated by wetland plants).

Bioretention systems and available space

Sediment basins, ponds and wetlands usually require a large area to ensure effective detention time for the settlement and removal of particulate matter, and contact time with plants, algae and associated biofilms for the removal of nutrients. Bioretention systems can be effective in managing stormwater runoff from smaller residential or industrial areas where available space is limited. Bioretention systems consist of an excavated basin or trench that is filled with porous media and planted with vegetation. The media in bioretention systems may range from sandy loam to gravel, and the vegetation from sedges to shrubs and small trees. Bioretention systems integrate the physical process of water filtration with biological water treatment. Due to this filtration process the terms "biofilter", "biological filter" and "biofiltration system" are also used.

Treatment processes with bioretention

As the stormwater passes through the bioretention system larger particulates are removed by sedimentation (pre-treatment to remove coarse sediment is desirable, to reduce the risk of clogging the infiltration media). Fine particulates and dissolved pollutants are removed from solution by the biological components of the system which include the vegetation and biofilms. The bioretention systems can be designed either to allow the filtered stormwater to percolate into the natural soil for groundwater recharge, or to collect in perforated drainage pipes leading to a designated outlet.

Plant species for bioretention

Plant species selected will depend on the substrate media. *Lomandra longifolia and Carex fasicularis* are two robust species that will grow in gravel (5-20 mm) as well as sand, and can withstand extended dry periods. Plant species that can tolerate both periods of inundation and drought should be selected depending upon the local climatic conditions. The vegetation also improves the scenic amenity of the system so that it becomes a landscaping asset.

Treatment efficiency of bioretention systems

Despite the potential to incorporate bioretention systems into urban stormwater management and the landscape design of new residential developments, or the retrofit of older areas, limited performance data have been collected on their treatment efficiency or the best design to maximise treatment efficiency.

Key research questions being addressed by researchers in the School of Environmental Engineering at Griffith University include:

1. Which substrate media should be used (e.g. loam, sand, gravel or a layered mixture of these)?
2. What depth of substrate (i.e. how deep should the trenches or basins be)?
3. Should top soil or mulch be applied?
4. What is the role and relative importance of plants and biofilms in the physico-chemical and biological processes of sediment and nutrient removal?
5. Which plant species are most suitable?
6. Will a dense cover of plants and/or mulch maintain moisture in the upper substrate?
7. To what extent will a dense cover of grasses, sedges (e.g *Lomandra*) enhance filtration in flood events?

Nature and development of biofilms

Biofilms are a community of microorganisms that adhere to any moist surface. The community comprises mostly bacteria that secrete and exist within a slimy gel-like matrix of extra-cellular polymeric substances (EPS). This matrix may also be colonised by protozoa, algae and fungi. Biofilms can improve water quality in biofiltration/bioretention systems by trapping fine

NEW INDUSTRY REPORT

WATER SENSITIVE URBAN DESIGN: A STORMWATER MANAGEMENT PERSPECTIVE

by

Sara Lloyd
Tony Wong
Chris Chesterfield

Industry Report 02/10

In response to the need for reliable, cost-effective, environmentally-friendly, robust and aesthetically-pleasing stormwater treatment measures, the CRC for Catchment Hydrology undertook research to develop new and existing stormwater quality improvement practices. The integration of these and other water conservation practices into urban design is referred to as Water Sensitive Urban Design (WSUD) and its principles can apply to individual houses and streetscapes or to whole catchments.

Fundamental to successfully applying WSUD principles to urban development is an understanding of the performance capabilities of structural stormwater management strategies, their life cycle costs and market acceptance. This report centres on the design process, construction activities and monitoring of environmental, social and economic performance indicators associated with Lynbrook Estate's Demonstration Project.

This report is available through the Centre Office for $33.00 (includes GST, postage and handling).

NEW WORKING DOCUMENT

NON-STRUCTURAL STORMWATER QUALITY BEST MANAGEMENT PRACTICES - GUIDELINES

by
André Taylor

Working Document 02/6

This working document presents a new evaluation framework for measuring the effects and life-cycle costs of non-structural BMPs. This framework defines seven different styles of evaluation to suit the needs and budgets of a variety of stakeholders involved with stormwater management. In addition, monitoring protocols and data recording sheets have been developed to support each style of evaluation.

A printed and bound copy of this report is available from the Centre Office for $22.00 including GST, postage and handling.

The report is also available as an Adobe pdf file and can be downloaded from http://www.catchment.crc.org.au/publications

particulates and taking up and transforming dissolved pollutants. Introducing vegetation or organic matter into the biofiltration/bioretention may provide an additional carbon source that enhances the development of the biofilm. The plant roots provide another surface area for biofilm growth, and the diffusion of oxygen from the roots provides aeration.

A pilot study has just been completed to develop methods for quantifying biofilm growth on gravel substrates. The results have shown that biofilm communities on gravel surfaces produce an extensive network of slimy EPS in which the bacterial cells are embedded (Fig 4.1)

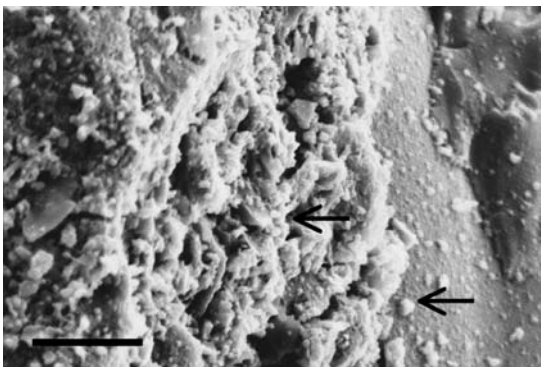

Figure 4.1
Scanning electron micrograph (2 600 x magnification, bar = 10 mm) of gravel demonstrating that biofilm EPS envelopes the microbial cells (←). The sample was prepared to preserve EPS. (Photograph Eloise Larsen)

This sticky matrix would assist in trapping fine particulate matter. Soluble nutrients would diffuse into the bacterial cells facilitating nitrogen removal through nitrification/denitrification.

Plant Growth

The growth of Lomandra and Melaleuca are being monitored at the Hoyland Street Bioretention System constructed by Brisbane City Council. In this system the infiltration media is sandy loam. (Figures 4.2, 4.3)

Lomandras are also being monitored at Spencer Road Bioretention System constructed by Gold Coast City Council. In this system the infiltration media is gravel.

In addition experimental pot trials are being established using different substrates – sandy loam, sand, gravel and a variety of native shrubs and grasses.

Monitoring Performance Efficiency of Bioretention Systems

– Field Sites
  Brisbane City Council will be installing autosamplers to monitor water quality at the Hoyland Street Bioretention System. There are three inlets and one outlet to this oval-shaped bioretention basin.

  The Spencer Road Bioretention System constructed in May 2002 consists of two parallel trenches 205 m long, 2 m wide and 1.2 m deep (Figure 4.4). Each trench has 3 x 60 m sections filled with different size gravel. In one trench the last two sections are planted with Lomandra. The Gold Coast City Council has installed autosamplers at the inlets and outlets. Base flow and storm event monitoring is being undertaken by Griffith University and Gold Coast City Council.

– Pot Trials
  Pilot scale bioretention "wheelie bins" with different substrates and plants will be dosed with synthetic stormwater runoff to investigate suspended solid and soluble nutrient removal.

Figure 4.2 Hoyland Street Bioretention System January 2002

Figure 4.3 Hoyland Street Bioretention System October 2002

– Laboratory Experiments
  Columns packed with different substrate, with and without (i.e. sterilised) biofilm growth, will be dosed in the laboratory to investigate adsorption of phosphorus as well as retention and removal of suspended solids and nutrients.

Figure 4.4 Spencer Road Bioretention System August 2002 (Photograph Colin McMurtrie)

Next steps

This work will be an important component of the Urban Stormwater Quality Program's fundamental research over the next three years. By evaluating the effectiveness of the pilot systems for water quality improvement and understanding the physical, chemical and biological processes involved we will be able to provide improved design guidelines for bioretention systems to manage stormwater quality and enhance landscape.

Margaret Greenway
Tel: (07) 3875 7492
Email: m.greenway@mailbox.gu.edu.au

NEW SOFTWARE

MODEL FOR URBAN STORMWATER IMPROVEMENT CONCEPTUALISATION (MUSIC)

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

MUSIC is available from the Centre Office for $88.00

Individuals will need to sign a Licence Agreement (available from the Centre Office and website: www.catchment.crc.org.au)

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

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

NEW TECHNICAL REPORT

STOCHASTIC GENERATION OF ANNUAL RAINFALL DATA

by

Ratnasingham Srikanthan
George Kuczera
Mark Thyer
Tom McMahon

Technical Report 02/6

One of the goals of the Climate Variability Program in the CRC for Catchment Hydrology is to provide catchment and river managers, and other researchers in the CRC, with computer programs to generate climate data. The need is for this at time scales from less than one hour to a year, and for point sites through to large catchments like the Murrumbidgee and the Fitzroy. Our first report (CRC Technical Report 00/16) in this series is a comprehensive literature review; in it a number of techniques are recommended for testing.

This is the first of several reports assessing stochastic data generation techniques. It includes tests of several models to generate stochastically annual rainfall data at 44 sites across Australia.

Copies of this report are available through the Centre Office for $27.50 (includes GST, postage and handling).

PROGRAM 5

CLIMATE VARIABILITY

Program Leader
FRANCIS CHIEW

Report by Alan Seed

Stochastic forecasts of rainfall

Lead-times for forecasts

The value of a quantitative rainfall forecast increases sharply with lead-time and many applications in the water industry could use forecasts of rainfall with lead times of 12 – 96 hours. There is also a need for rainfall forecasts with lead times that are less than 12 hours, for example flood warning in small or urban catchments.

Unfortunately, the accuracy of Numerical Weather Prediction (NWP) forecasts is not very high for lead times that are less than 12 hours due to problems in "spinning up" the NWP model.

'Nowcasts'

'Nowcasts' of rainfall are based on extrapolating the observed rainfall field, but the accuracy of these methods decreases rapidly with increasing lead-time, and are generally only of use for lead-times of up to about 90 minutes. There is thus a difficult period of 1-12 hours where quantitative rainfall forecasts are likely to be most useful to operational applications, flood forecasting for example, but where existing forecasting techniques are inadequate.

Proposed new CRC project

The proposed CRC project 5A will conduct joint research with the Met Office (U.K.) into developing a new paradigm for rainfall forecasting, an approach that recognises that the skill in quantitative rainfall forecasts is limited, and therefore presents the rainfall forecasts either as a probability distribution or an ensemble of forecasts that are conditioned on either the current rainfall or a NWP forecast. The ensemble of forecasts can then be routed through a hydrological model so as to produce a probability distribution of forecast river flows.

Accuracy of nowcasts

Quantitative nowcasts of rainfall are based on the advection of the observed rain field forwards in time. The accuracy of the nowcasts depends on the rate at which the field is developing in Lagrangian coordinates, the accuracy and resolution of the advection estimates, and the accuracy of the radar reflectivity to rainfall conversion. In any event, the accuracy of the nowcasts rapidly becomes pedestrian and the maximum lead-time is generally less than one hour for quantitative rainfall forecasts.

In addition to the feasibility study proposed for nowcasts as noted above, work has progressed on a method used to generate stochastic nowcasts. Preliminary results based on a rain event in Melbourne can be presented here.

Generating stochastic nowcasts

– Method

The method used to generate stochastic nowcasts is based on the S-PROG model (Seed, 2002). The basic premise of S-PROG is that rain fields are scaling and a rain field consists of a hierarchy of features (cascade) over a wide range of spatial scales, and the lifetime of a feature is a power law of the scale of the feature (or level in the cascade).

In effect, the forecast is a deterministic forecast based on advection blended with stochastic noise, which progressively dominates the larger scales as the features in the various levels in the cascade perish until the field becomes independent of the initial (observed) field. The crucial part of the method is to specify an appropriate set of noise fields at the start of the forecast period and to update these noise fields during the forecast period.

At present an ad hoc scheme to test the ideas was used to initialise the noise fields. The first level in the noise cascade is generated as a field that has a correlation of 0.7 with the first level in the observed cascade, or 50% of the variance in the noise field can be explained by the observed field.

An examination of the observed cascade revealed that there was a weak correlation between pairs of levels in the cascade, so the lower levels in the noise cascade were generated as fields of noise that were correlated with the previous cascade level using the estimated correlation between the observed cascade levels, and smoothed with an appropriate band-pass filter.

The noise cascade is updated from one time step to the next in the forecast period using the AR(2) model parameters that are derived from the observed field, and then advecting the noise using the observed advection field.

– Results

These ideas were tested using data from a significant widespread rainfall event that was recorded by the Melbourne radar on 22 April 2001. Figure 5.1 shows an observed field, and Figure 5.2 shows the 30,60,90,120 minute forecasts respectively.

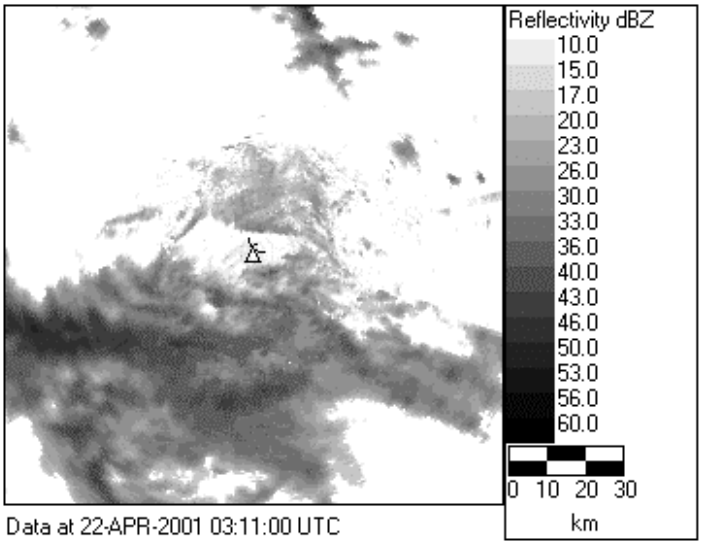

Figure 5.1. Observed field of radar reflectivity

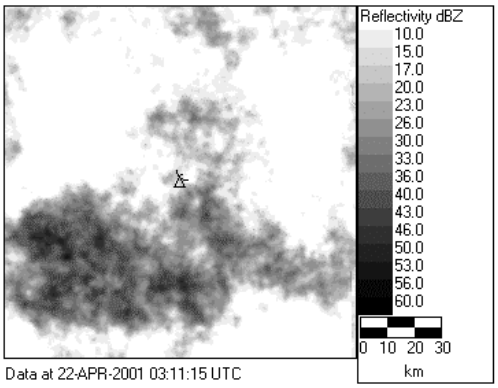

Figure 5.2 (a)

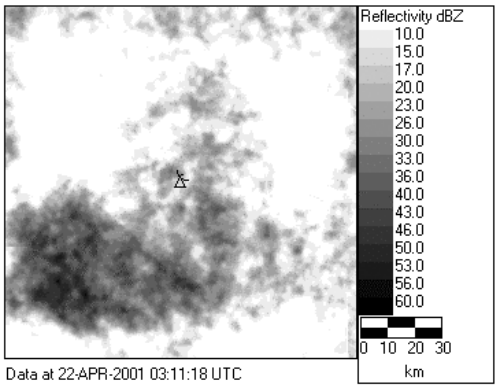

Figure 5.2 (b)

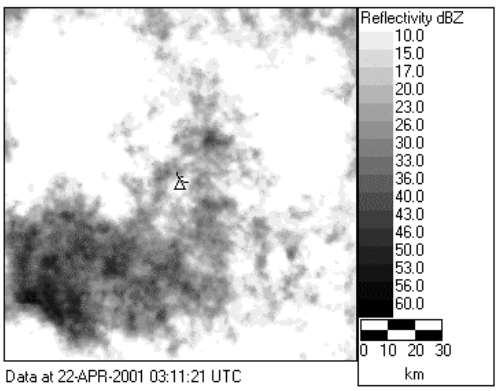

Figure 5.2 (c)

Figure 5.2a,b,c,d.
Examples of 30, 60, 90, 120 minute stochastic forecasts conditioned on Figure5.1.

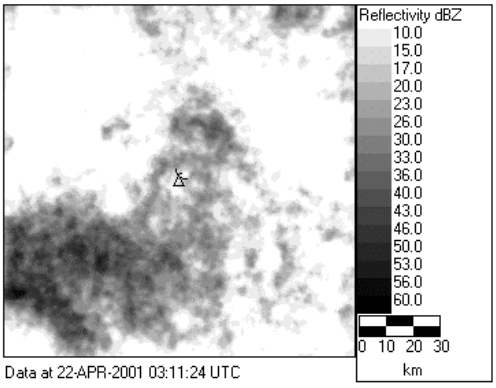

Figure 5.2 (d)

NEW TECHNICAL REPORT

ON THE CALIBRATION OF AUSTRALIAN WEATHER RADARS

by

Alan Seed
Lionel Siriwardena
Xudong Sun
Phillip Jordan
Jim Elliott

Technical Report 02/7

Weather radar offers an enormous potential to improve the quality of rainfall measurement. This potential can translate into benefits in many sectors of the water industry ranging from improved design information, decisions on water allocation and management, through to improved weather and flood forecasts for greater public safety.

A key step in transforming weather radar observations into accurate rainfall estimates however is the calibration of the weather radar data. This involves converting the quantity actually observed by the radar (known as reflectivity) into an estimate of rainfall intensity. The current approach used widely with Australian weather radars is to rely on a set of calibration factors that represent average, or climatological, conditions. This can lead to quite large errors in rainfall estimates.

This report describes investigations to improve the calibration process for weather radars in Melbourne, Sydney and Darwin. Rain gauge data has been used to analyse the likely errors in rainfall estimates from radar and calibration strategies to improve the quality of the radar rainfall estimates are proposed.

Copies of this report are available through the Centre Office for $27.50 (includes GST, postage and handling).

NEW TECHNICAL REPORT

STOCHASTIC GENERATION OF MONTHLY RAINFALL DATA

by

Ratnasingham Srikanthan
Tom McMahon
Ashish Sharma

Technical Report 02/8

One of the goals of the Climate Variability Program in the CRC for Catchment Hydrology is to provide water managers and researchers with computer programs to generate stochastic climate data. The stochastic data are needed at time scales from less than one hour to a year and for point sites to large catchments like the Murrumbidgee and Fitzroy.

The first report in this series, 'Stochastic Generation of Climate Data: A Review' (CRC Technical Report 00/16), reviewed methods of stochastic generation of climate data and recommended the testing of a number of techniques. The second report, Stochastic Generation of Annual Rainfall Data' (CRC Technical Report 02/6), compared the first order autoregressive and hidden state Markov models for the generation of annual rainfall data. This third report, 'Stochastic Generation of Monthly rainfall Data', tests the method of fragments and a nonparametric model for the generation of monthly rainfall data at ten sites across Australia.

Copies of this report are available through the Centre Office for $27.50 (includes GST, postage and handling).

Conclusions

The feasibility study showed that it is possible to generate a stochastic series of rainfields that are conditioned on the current scene. These techniques can also be used to "downscale" NWP forecasts from the scale at which the NWP forecasts have significant skill (likely to be of the order of 100 km and several hours) to the scale required for operational hydrological decision making.

Stochastic forecasts recognise the fact that it is very unlikely that the NWP models will be able to produce quantitative rainfall forecasts that have skill at small space and time scales in the near future, due largely to problems in measuring the initial conditions at an appropriate scale. The challenge however is to develop methods to use these probabilistic forecasts in operational hydrology.

References

Seed, A.W. (In press). *A dynamic and spatial scaling approach to advection forecasting*. J. Appl. Meteorol..

Alan Seed
Tel: (03) 9669 4591
Email: a.seed@bom.gov.au

PROGRAM 6
RIVER RESTORATION

Program Leader
MIKE STEWARDSON

Report by James Grove

Baring all on the Riverbank: the problems involved in visual assessment of riverbank erosion

Introduction

I am a Postdoctoral Fellow funded by the British Royal Society. I am working at the University of Melbourne, with the team of the CRC River Restoration Program (Program 6). In my one year in Australia, I am exploring various aspects of stream bank erosion with Ian Rutherfurd, concentrating on the Kiewa and Acheron Rivers. In this article I will discuss whether it is possible to assess bank erosion severity from a visual assessment.

Stream Condition Indicators

As in the UK, there is a proliferation of 'stream condition' indicators in Australia (eg. The Index of Stream Condition; the State of the Streams Method (Anderson)). Not surprisingly, most indicators include some measure of the 'stability' or erosion rates, in a stream. This is, by necessity, based on a general assessment of how raw and bare the banks look. Similarly, the SedNet model, which estimates the sediment yield from a catchment, sets the erosion rate at zero if there is banktop vegetation. The implication being that a vegetated bank has no erosion.

Vegetation and Stability

We can make two mistakes here. First assuming that a vegetated bank is stable, and second assuming that a raw, vertical bank is unstable. There are many cases where neither assumption is true. The aim of this article is simply to urge caution in making visual field assessments of erosion rates.

Seasonal variation in vegetation coverage, the rate of vegetation re-establishment, and bias introduced by the visual prominence of different sized failures will all be discussed with reference to bank erosion sites that we are monitoring on the Kiewa River in NE Victoria, and also from sites in the UK. We selected the Kiewa River for study because it is essentially unregulated (apart from the small Rocky Valley storage).

Vegetation Seasonality

The erosion process that is active in a section of river may be misinterpreted as a result of the amount of vegetation that is present during a visual survey. This problem may be most severe in the headwaters of a catchment. Low rates of erosion contributed by frost heaving of bank material, or desiccation, will be greatly affected by the amount of the bank that is devoid of vegetation. The most upstream site on the Kiewa study (at Mulindolingong) was subject to frost action, resulting in high lateral erosion rates of 35 mm per year. If a bank that is prone to frost action is assessed in the summer months when vegetation is at its peak coverage then the area of eroding bank will be underestimated.. The five Kiewa sites were selected during the winter months of May and June when vegetation was at a minimum, and have since then had a greater coverage of vegetation over the bank surface. An example of this change in vegetation coverage may be observed at the Gundowring monitoring site (Figure 6.1).

Figure 6.1: The change in vegetation coverage at Gundowring between 23 June 2002 and 22 October 2002. Long grass has covered the sparsely vegetated bank face.

Vegetation Establishment Rates

In the past, if a bank face was covered with moss, we assumed that it must be stable because moss takes a long time to grow. At the Kergunyah site, on the Kiewa, a slab failure caused over 280 mm of erosion on a section of bank between 23 May and 27 June 2002. A site visit on the 24 July 2002 revealed that the bankface had already been colonised by moss. If we did not have the measurements, the moss would have prompted us to classify this as a stable site. Subsequent high flows have not entrained the moss but it was removed, along with underlying sediment, in thin slab failures approximately 20-30 cm in depth (Figure 6.2). Theoretically there must be a minimum level of disturbance to maintain a bare bank surface. Rates of erosion of zero mm per year have been measured during some periods on the Kiewa – minimum erosion required to maintain a bare surface will be a product of the erosion over an annual cycle. Current research by Dom Blackham (in the River Restoration Program) on the shear stresses required to remove, or disturb, grasses may give some indication on the frequency of flow events needed to keep a surface bare of grass.

OTHER OUTLETS FOR CRC PUBLICATIONS

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

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

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

WORKING DOCUMENT

APPLICATION OF HIDDEN STATE MARKOV MODEL TO AUSTRALIAN ANNUAL RAINFALL DATA

by

Ratnasingham Srikanthan
Mark Thyer
George Kuczera
Tom McMahon

Working Document 02/4

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

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

Copies are available through the Centre Office for $22.00.

Visual Prominence

The type of erosion process operating may also bias estimates of bank erosion rates and processes. Large mass failures, such as landslides, are visually prominent and easily observed when walking along a banktop (Figure 6.3). The frequency of these failures is difficult to determine without the use of monitoring or remotely sensed images. Intensive monitoring on the River Swale, U.K revealed that the most downstream sites had the greatest bank heights and the largest mass failures (Figures 6.4 – 6.6). The frequency of these failures decreased downstream and although sites appeared to be very active they were in fact infrequently eroding by mass failures. Surfaces were kept bare by desiccation and rainsplash erosion making it appear that failures were 'fresh'. At three of the monitoring sites the average rate of erosion over the bankface, during each measurement period, showed that the most upstream site (Figure 6.4) was eroding at the same rate as the most downstream site (Figure 6.6). Despite their smaller size the high frequency of failures in the mid-catchment (Figure 6.5) resulted in greater rates of erosion.

On the Mississippi it was found that plugs of clay sediment caused 'hard-points' that affected meander migration. The more resistant clay constrained meander development by slowing erosion. The clay plugs were visually more prominent as they remained as shear bank faces whilst the surrounding material collapsed, and was then entrained by the flow. The more visually prominent plugs were therefore only more prominent because they were the points of least erosion.

Smaller block type failures may result in accumulation of material at the bank toe, or the failed material can be rapidly entrained, depending on the efficiency of flood removal. Stage at the time of assessment may hide blocks of material that are resting at the bank toe protecting it from further undercutting. The site near Albury-Wodonga has maintained a basal shelf of material despite high stages, slowing the rate of undercutting and subsequent mass failures. This may be one factor behind the rate of erosion decreasing from 890 to 105 mm per year during June and July 2002, with insufficient flows to removal basal material.

Figure 6.2: A slab failure in the foreground has removed the bank face to a depth of ~20 cm. The moss is still covering the bank in the background, despite recent inundation.

Figure 6.3: A mass failure observed at Topcliffe (2 February 1997).

Recommendations

1. Do not assume that a vegetated bank is a stable non-eroding surface;
2. A bare bank surface may not be rapidly eroding, requiring only tens of mm per year to maintain a unvegetated surface;
3. Large mass failures may be misleading, resulting in an overestimation of the rate of erosion;
4. If at all possible assess if there is basal material protecting the lower bank from further erosion.

James Grove
Tel: (03) 8344 3947
Email: jrgrove@unimelb.edu.au

Figure 6.4: Beck Meetings, the most upstream of the River Swale monitoring sites. Frost heaved sediment has accumulated at the base of the ~ 1m high bank (28 February 1997).

Figure 6.5: The Reeth monitoring site mid-catchment on the River Swale (15 January 1997). The 2 m high bank was modified by slab, pop-out and cantilever block failures. Flow is into the page.

Figure 6.6: Topcliffe, the most downstream site on the River Swale (18 November 1995). The banks are approximately 4 m high, and flow is into the page.

NEW WORKING DOCUMENT

STOCHASTIC MODELLING OF DAILY RAINFALL

by

Senlin Zhou
Ratnasingham Srikanthan
Tom McMahon

Working Document 02/5

Stochastic generation of rainfall data offers an alternative to the use of observed records. This paper presents an evaluation of daily rainfall generation models at 21 stations across Australia. The models are the Transition Probability Matrix (TPM) method, the Daily and Monthly Mixed (DMM) algorithm, and a variation of each model.

A goal of stochastic modelling is to generate synthetic data that are representative of the statistical characteristics of the historical data. One hundred replicates of length equal to the historical data were generated using the above models. Preliminary assessment of the models suggests that overall both the TPM and DMM models preserved key statistical characteristics of the historical rainfall at the annual, monthly and daily levels. The DMM model was unable to preserve the amounts of rainfall on solitary wet days and the TPM model needed to be modified by the empirical adjustment factor to preserve the annual variability.

Copies of this report are available through the Centre Office for $22.00 (includes GST, postage and handling).

DOWNLOAD CRC REPORTS

All of the CRC's reports since 1999 can be downloaded from our website at www.catchment.crc.org.au/publications

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

PROGRAM 7

COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect November 2002

At a glance – a summary of this article

Digital versatile disc (DVD) players have surpassed all previous levels for the adoption of a new product in Australia, North America and the United Kingdom. What contributes to such a high rate of adoption for a new product?

Purchased a DVD player recently?

Hands up if you own a Digital Versatile Disc (DVD) player! Hmmm, from here with a quick count it looks like about one quarter of you and that puts *Catchword* readers at about the national level in terms of DVD player ownership. Not bad for a product that was launched in Australia in September 1998. The take-up rate of DVD players in Australia has been quicker than microwave ovens, compacts discs, television and even mobile phones. Phillipa Meppem, Sony's DVD product manager said recently "it (DVD) has been the fastest pick-up of any technology introduced into the Australian market". And its not just the Australian market.

Back in 1997, industry sources forecast that the consortium of multinationals who created DVDs (a group of large electronic manufacturers including Philips, Sony, Toshiba, IBM, Pioneer, General Electric and JVC) could expect to sell 7 million DVD players in North America by 2000 and 40 million by 2006. At the end of last year, over 35 million DVD players had been sold in North America surpassing all industry expectations; another 20 million will sell during 2002. The DVD player achieved a level of market penetration (sales to consumers) in three years that took the CD player and video recorder almost seven years.

Forecasting product uptake

So it seems even the professional marketing experts can't always predict the success or otherwise of a new product in a market place - although in this case, an underestimation of five years is the best way to be wrong.

Naturally there isn't a formula for ensuring the successful introduction of a new product, otherwise we would all be using teletext on our TVs at home, patiently feeding food scraps into our garbage disposal units and listening to our favourite music in quadraphonic (four channels compared to stereo's two).

When marketers forecast and plan for the likely uptake of a new product, two key components are of much interest: the product, and the potential consumers of the new product (the target market). For the purpose of this article I will focus on the product.

Product Characteristics

Researchers have identified five product characteristics that seem to influence consumer's acceptance of new products (Schiffman *et al.*, 2001):

- Relative advantage
- Compatibility
- Complexity
- Trialability
- Observability

It may be worth casting an eye over DVD players in this context to see what has contributed to its success.

– Relative advantage

This is the degree to which potential end-users perceive a new product as superior to existing substitutes. So what is the relative advantage of DVD players over video players? Well the format is the same size as a CD so it's convenient in terms of storage and handling, the picture quality is 40% better than VHS videos, they're less liable to damage from heat, they have near instant searching, no advertisements, extraordinary sound when combined with an appropriate audio system and their storage capacity allows additional footage, information and even choices of how a movie may end. Not a bad start!

– Compatibility

Compatibility describes the degree to which potential end-users feel a new product is consistent with their present needs, values and practices. DVD players are popular because they meet one of the human requirements for entertainment. Even better, they allow us to be entertained in our own home (convenient and comfortable) and are very similar to our existing and accepted behaviour of finding 'relaxation' in front of the television (not all of us, but many!).

– Complexity

The easier a product is to understand and use, the more likely it is to be accepted. In the case of DVD players they operate (as I'm sure you could guess if you don't already know) in the same way a CD player or even an old cassette tape player does. Yes there are subtle differences, but basically the buttons and functions are the same. Recently I found myself in the driver's seat of a DVD for the first time and I could operate it capably. Of course it is not by accident. Imagine if DVD players had a completely foreign

control panel that required adjusting the strength of the laser beam and disc speed to ensure a perfect image – that would be a lot harder to sell wouldn't it?

– Trialability
Trialability refers to the degree to which a new product is capable of being tried on a limited basis. If the opportunity to try a new product is readily available and easily undertaken, the easier it is for end-users to evaluate the product and (potentially) adopt it. How easy is it to trial a DVD player? As easy as going to your local electrical store and asking for a demonstration. It is for the same reason supermarkets and other companies offer you free samples of products and services. They want to make it risk free and as easy as possible for you to trial their product, evaluate its merit, and purchase it.

– Observability
The observability of a product refers to the ease with which a product's benefits or attributes can be observed, imagined or described to potential consumers. It highlights the importance of communication in the process of adoption of new products. A DVD player's advantages are easily described and advocates would probably draw comparisons with 'the cinema experience' in relating its benefits to an interested person.

DVD players – getting the picture?

On the basis of each of these five criteria it is clear that DVD players score highly as a new product and these characteristics must contribute to its unparalleled success and rate of adoption. After all this you may well be asking yourself why I have written an article about DVD players in *Catchword*. It is because I am suggesting that for the CRC to introduce a 'new product', these product characteristics are likely to be very important. For example, the CRC's Toolkit will be shortly entering the catchment modelling and management 'marketplace'. The CRC team must carefully develop and refine the evolving Toolkit products in light of each of these characteristics to ensure the highest possible level of adoption.

As always, I would be interested in your feedback on this article.

References:

This article draws heavily on Chapter 17 'Diffusion of innovations' in: Schiffmann, L., Bednall, D. Cowley, E., O'Cass, A., Watson, J. and Kanuk, L. (2001) Consumer Behaviour. Pearson Education Australia Pty limited.

Information about the uptake and characteristics of DVD players came from:

- Sydney Morning Herald, 17 February 1997
- Financial Times (London) 20 June 1997
- The Weekend Australian, 28 March 1999
- Daily Mail (London), 21 December 2001
- Audio Week (USA), 6 May 2002
- Sunday Age (Melbourne), 13 October 2002.

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

WHAT'S HAPPENING WHEN?

FIND OUT ABOUT CRC ACTIVITIES BY EMAIL

THE CRC WILL NOTIFY YOU OF AN UPCOMING CRC ACTIVITY IN YOUR AREA OF INTEREST

You can register to receive this information on line at www.catchment.crc.org.au/subscribe

or you can contact Virginia Verrelli at the Centre Office on 03 9905 2704.

CRC ANNUAL REPORT 2001/2002 AVAILABLE

The CRC's Annual Report for the 2001/2002 financial year is now available in hard copy or can be downloaded from the CRC website at www.catchment.crc.org.au /publications

Choosing 'Other' publication types will reveal the Annual Report listing and associated Adobe .pdf files by sections of interest.

To request a printed copy of the report please contact Virginia on 03 9905 2704 or email crcch@eng.monash.edu.au

POSTGRADUATES AND THEIR PROJECTS

Debbie Woods

Background

Hi, my name is Debbie Woods and I have had the privilege of being part of the CRC for Catchment Hydrology for a year now.

I graduated from RMIT University in 1998 with an honours degree in Environmental Engineering. After graduation I worked for World Vision Australia for a year to gain experience in the field of international development and to take some time to decide which field of engineering I wanted to work in. At World Vision, I was part of a team administering Child Sponsorship and Area Development Programs for Africa and Latin America. During that time it became clear to me that my interests were in the areas of dams, irrigation and environmental hydrology. An ideal position to incorporate all this was found at SMEC Victoria. After a short trip overseas I commenced working at SMEC in March 2000. I was involved in a wide range of consulting projects while at SMEC, including asset management, preparation of the Alfred Deakin Irrigation Area feasibility study and corporate environmental report verification. I worked at SMEC for 18 months before the call of further education beckoned me.

I started a PhD at Melbourne University in October 2001 in the Environmental Flows Project under the supervision of Assoc Prof Ian Rutherfurd and Dr Michael Stewardson. After a long journey of topic definition, I finally decided to focus my research on environmental flows for Australia regulated rivers.

Reflecting back on where my interest for the environment and regulated rivers stemmed from, I recalled a childhood memory of growing up in Rutherglen and riding my bike around Lake Moodamere and thinking that there were way too many mosquitoes. I seem to have come full circle, as part of my research will be looking at flooding of wetlands on the River Murray from Hume Dam to the Barmah-Millewa Forest, with Lake Moodamere being one of the connected lakes that has crossed my research path.

About my project

The definition of environmental floods that I have developed is *"re-creating seasonal flooding patterns to restore or maintain ecological processes and natural resources, such as flood adapted plants and animals, or flood-dependent geomorphic features"*. The aim of my research is to assess the feasibility of environmental floods to be used in the management of Australian regulated rivers.

My research is focussed on the hydrology as opposed to the ecology of environmental flood releases. There are two main components of my thesis. The first is to assess which regulated rivers in southeast Australia require flood releases based on deviation from their natural flood regime and to then set priorities for these rivers for environmental flood releases. Priory setting will be based on physical aspects such as rarity and representativeness of a flood regime across a State, tributary inflow, and the location of dams in the catchment.

The second part of my research aims to assess the feasibility of environmental flood releases. There are many aspects that can limit the release of an environmental flood. These include legal obligations, lack of scientific predictive ability, infrastructure not suitable to release a flood, cost of water for flood releases and power imbalances in decision making. The limitations and feasibility of environmental flood releases will be explored using a case study approach. The Barmah-Millewa Forest, which to date has had two environmental floods released, and the Lower Thomson River, which has had environmental floods proposed are both earmarked as study sites.

I am enjoying being a part of the wider CRC for Catchment Hydrology "family" and am appreciative of the support and resources that are supplied to assist me along the bumpy, but fulfilling PhD journey. If you have an interest in my research topic and would like to provide input into the research processes, I would be keen to hear from you.

Debbie Woods
Tel: (03) 8344 3947
Email: d.woods1@pgrad.unimelb.edu.au

CRC PROFILE

Our CRC Profile for November is:

Susan Cuddy

Current Position

I am a senior experimental scientist within the Integrated Catchment Management Research Directorate in CSIRO Land and Water. I find it hard to believe, but I have now worked for CSIRO for 18 years. Though the name of the division and the name and composition of the group has changed many times, I have always worked in software teams developing and deploying environmental software for catchment management. My role depends on the team composition and ranges from systems analysis, design, implementation and deployment through to GIS processing and project management. My CRC for Catchment Hydrology involvement comes through Project 1.1 (and soon to be project 1A) - the Modelling Toolkit Project. Within that project, I have coordinated an Associated Project (the development of the Environmental Management Support System (EMSS) within South-East Queensland), and worked on toolkit surveys and software design and deployment. I have also been rather engaged in preparing appropriate licence agreements between CSIRO and the CRC for Catchment Hydrology for marketing and distributing software.

Life & Career History

I started life as a Queenslander, born to pub owners in Rockhampton. My only memory of my life in Rockie is of keeping watch for cops on Sunday mornings when my dad's mates dropped in for a quick drink on the way home from church. Maybe that precipitated our move as, at the age of 3, we headed to the Gold Coast and built and ran a small motel at Burleigh Heads. With my two sisters, I attended the local Catholic schools. We were all very competitive – athletics, swim club, piano exams and schoolwork as well. I was also a goodie two-shoes, but that didn't seem to inhibit my fun. I had a wonderful childhood.

At the tender age of 17, I left home for the big smoke – Brisbane and Queensland Uni to do an Arts degree majoring in Pure Maths and German Literature. That was the year of my social awakening with anti-apartheid rallies during the Springbok tour and working with local Aboriginal organisations. Only a three year degree and at 19 I graduated. To what you might ask? I worked in Brisbane for a financial adviser for a few years - a few graphs and lots of typing - then headed to Darwin with friends. My maths background got me into programming and that was my life for the next 8 years. I became a systems programmer, then database analyst and administrator, in the Northern Territory government. This was a large centralised system – the first large government agency to convert from batch to online processing for applications such as motor vehicle registration and licensing, hospital administration, etc. Well, on reflection, my life in Darwin was rather wild! I worked and played hard – and extended my give-it-all work ethic to hockey and politics. I loved my work and finally realised that I wanted to learn more. I came to Canberra in 1984, on holidays, to do the Graduate Diploma in Computing Studies at Canberra CAE (now Canberra Uni).

In August 1984 I started work for CSIRO Land and Water Resources under John McAlpine in the PNG group and my plan to return to Darwin disappeared. The next few years were wonderful. The PNG Group was unique - a multi-disciplinary team made up of an ex-kiap, geomorphologist, pedologist, climatologist, anthropologist, crop eco-physiologist, cartographer, forester, programmer. We were the first group in the Division to use PCs. I travelled to PNG many times to train departmental staff. However, it was the end of an era and the old guys, including all the Dutch soil scientists, were heading out the door. The bitter breakup of that Division to become the Division of Water Resources saw the PNG group transferred to Brisbane. As a Queenslander in exile, what was I to do?

I moved into the Resource Management Systems group (under Dr Richard Davis) and worked on the development of a spatial expert system to predict the environmental impact of training exercises at Puckapunyal Army training base. That was a great job and I fell into an area of computing that I continue to love - spatial and qualitative modelling and knowledge representation. Since then, I have worked on many software development projects within the Division. My role has been mainly project co-ordination and systems design and includes development and applications of the CMSS and ICMS packages, and large model integration projects. Some examples are the 'Environmental Flows Decision Support System' (EFDSS) with Bill Young, and 'Tool for Assessing Water Supply' (TAWS) which integrated storm and waste-water streams into an urban water reticulation water supply package. As you can see, I have been around for a long time, and spend a lot of time managing project teams. This is not necessarily my favourite activity!

MUSIC USER MANUAL

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 1.00. software comes complete with an Adobe .pdf file of the MUSIC User Manual.

A colour printed and wire bound copy of the 134 page User Manual can also be purchased through the Centre Office for $110 (includes postage, handling and GST).

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

I have also been very involved in the CSIRO Staff Association and served as ACT secretary, then Councillor, for many years. This was a great way to meet people from other parts of CSIRO and, while my union involvement is now in recess, the friendships live on. I also cemented my partnership with my mate, Peter Fogarty, and started a life-long project, called Teah Cuddy Fogarty, born 9 weeks premature in 1995. A great way to stuff up work schedules! I am also still very involved in hockey, play for Canberra Uni and ACT Veterans, and am on the Executive of Hockey ACT and Council of Hockey Australia.

My time in the CRC for Catchment Hydrology, firstly under the tutelage of Rob Vertessy and now under Peter Hairsine, has proved to be beneficial to my career (well, I still have a job!), has given me the opportunity to continue to work in an area of computing that I love, and, most importantly, has given me the opportunity to mix and work with wonderful people from CSIRO and other organisations – what more can you ask for?

Susan Cuddy
Tel: (02) 6246 5705
Email: susan.cuddy@csiro.au

WHERE ARE THEY NOW?

Report by John Marsh

Where are they now?

John Marsh PhD student in CRC from 1996-2001 – now in The Gambia West Africa

I arrived in The Gambia, West Africa on March 13 2001, seven days after submitting my thesis. I joined my wife Annette who took up a post as an immunologist doing research on tuberculosis with the British Medical Research Council. I hoped I would find life interesting.

The Gambia is a small 'democratic' country (the currently 'elected' president assumed power in a coup in 1994). Its population of 1.4 million mostly Islamic (85%) poor (70%) farmers (70%) sits in one of the most neglected regions of the world. Africa is becoming increasingly put into the 'too hard' developmental basket, with West Africa being the bottom of this unfortunate heap. With most of its countries in the bottom twenty of world poverty list, in a region racked by wars (Sierra Leone, Liberia, now possibly Cote D'Ivoire), and now drought, life seems to lurch from one brink to another for most simply trying to scratch an existence from the soil. Fortunately Gambia in nestled wholly within Senegal, probably the most stable of countries of the region. A twenty-year independence struggle however in the part of Senegal to the south of Gambia (about 40km from where I sit while I write this) results in refugees coming across to The Gambia every year – the latest fighting and burning of villages there took place four days ago.

Well, life for me in The Gambia is certainly very different. Constant power cuts, fuel shortages, heat, dust, heavy rain and exhilarating thunder storms in the rainy season, budget and sex tourism on the beaches, recent sinking of a ferry with hundreds of dead bodies on the beaches, the fantastic mangoes and other fruits, laid-back form of Islamic life, calamatous dusty main streets and markets, widespread and grinding poverty, corrupt police at road blocks and the array of indescribable complications embedded in day to day life here (eg paying a phone bill) add up to an interesting experience, if not quite wearying at times. I would say that in the last 19 months or so there have been a few memorable moments. Among the exciting ones include the moment in August 2001 not long after I started my current job where I was electrocuted (thrown against the office wall) when a lightning strike hit our unearthed 30m radio mast and caused a lot of physical demolition of our office and started a fire (not to mention personal injuries to staff). The most memorable though, surrounded the birth of our first child Lola. Seven months into the pregnancy, my wife's waters broke a few days before she was due to fly back to Australia to prepare for the birth. We suspect it was the appalling roads that caused the rupture. As there are no decent medical facilities, especially for a premature baby, we managed to get ourselves up to Dakar (Senegal) on a commercial flight that night and finally Annette was flown on a medivac jet to London with a medical team who had come from Europe. But there was no room for me in this little jet after patients, medical staff and equipment, so I spent an agonising twelve hours or so flying separated on a commercial airline, only to arrive in Queen Charlotte's hospital in London to find Annette well and still pregnant. Annette gave birth to Lola hours after my arrival, 84 hours after the original alarm. We then stayed two and half months in London while Lola gained her strength and made our way back to Gambia after a brief 'show & tell' trip home to Australia in August when I also finally took the opportunity to attend a graduation ceremony at Melbourne University.

On the work front, I had managed to find some consultancy work on a World Bank project after about six weeks after initially arriving in early March 2001, and then some development work with an International NGO. In October 2001, I was appointed as the Director of a British NGO called Concern Universal (CU). CU had been working with local Gambia NGOs, the government and other humanitarian organisations in development and emergency, traditionally with projects in rural development and farmer training, food security. Since my time we have kicked off some new initiatives some with a strong market orientation. These include smallholder irrigation technologies, groundnut sector reform, horticultural marketing, emergency response for refugees, HIVAids, peace building and crisis prevention and some others. Rob Allison & Tracey Walker (both ex- CRC) came out for a three month jaunt with CU this year and enjoyed themselves I believe – contributing greatly to the water and horticultural projects. Managing an office, projects, staff and budgets, and mixing on a very regular basis with UN representatives, Ambassadors, EC Delegates and even meeting with the Vice-president of The Gambia in her office to discuss plans for a nation wide drought survey that CU are working on, means that life here is very different to the one I lead as an inconspicuous CRC student wandering the streets of Melbourne. I think I would say that I found something interesting to do here.

John Marsh
Email: johnmarsh@qanet.gm

First Announcement - SYMPOSIUM ON URBANISATION AND STREAM ECOLOGY

8-9 December 2003

Melbourne Australia

Expressions of interest are invited from ecological researchers and practitioners to attend the Symposium on Urbanisation and Stream Ecology.

The symposium will aim to:
- bring together and synthesize current knowledge of the effects of urban land-use on stream ecosystems
- examine priorities and potential for stream restoration in urban catchments
- identify knowledge gaps to direct future ecological research in urban catchments.

The symposium, to be held at an inner-city location in Melbourne in the austral summer of 2003, will consist of a day of plenary papers presenting some of the world's foremost research on stream ecology in urbanized catchments, followed by a day of contributed papers.
If you are interested in contributing a paper or attending the symposium, please send a message to Chris.Walsh@sci.monash.edu.au

Further announcements will be made in the coming months including a formal call for papers and more details on venue and registration.
The symposium is being supported by the Cooperative Research Centres for Freshwater Ecology and Catchment Hydrology, together with the Melbourne Water Corporation.

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

Print Post Approved
PP338685/00026

If undelivered return to:

Department of Civil Engineering
PO Box 60
Monash University
Vic 3800

SURFACE MAIL

POSTAGE PAID AUSTRALIA

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

crcch@eng.monash.edu.au

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
Melbourne Water
Monash University
Murray-Darling Basin Commission
Natural Resources and Mines, Qld
Southern Rural Water
The University of Melbourne
Wimmera Mallee Water

Associates:
Water Corporation of Western Australia