NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 112 DECEMBER 2002

A NOTE FROM THE DIRECTOR

Professor Rob Vertessy

Inside...

COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

A SPECIAL ISSUE OF *CATCHWORD*

In this special issue of *Catchword* we aim to demonstrate to readers the commitment of our Centre to integration and end-user needs. Our story is woven around the activities in each of our five focus catchments. These include the Yarra, Goulburn Broken, Murrumbidgee, Brisbane and Fitzroy river catchments. Our efforts are underpinned by an aim to predict whole-of-catchment behaviour in a holistic way. But before we launch into our focus catchment activities, I want to discuss how we are aiming to be 'integrated' and sensitive to end-user needs.

A CRC devoted to integration

Derived from Latin, the word 'integration, means 'to make whole'. So, exactly what are we meaning to make whole and why? Broadly speaking, we have three integration objectives within our CRC.

Our first integration objective is a scientific one, whereby we are aiming to link disciplinary knowledge from climatology, hydrology, geomorphology, ecology and economics and cast this in the form of quantitative models of catchment behaviour. Our belief is that such integration is required if we are to look at catchment function and response to change in a holistic way. Many have aspired to do this in the past but success has been elusive because it is technically and culturally difficult to link quantitative models from so many disciplines. In the last issue of *Catchword* I described our new research portfolio which contains projects based in each of these topic areas. One of our projects (Project 1B: Methods for integration in catchment prediction) is dedicated to integrating all of the models being developed by our various research teams, based on an underlying conceptual blueprint which each of the projects will conform to.

Our second integration objective is rooted in the domain of software engineering. It is one thing for a group of scientists to share a conceptual model of how their various pieces of disciplinary knowledge fit together, but quite another to formally integrate software-based encapsulations of that knowledge. This latter requirement is vital if end-users are to benefit from our integrated knowledge; they need something that they can apply. Hence, another one of our new projects (1A: Implementation of the Catchment Modelling Toolkit) is devoted to interlinking modelling products from each of the projects within a cohesive software framework, delivered via the World Wide Web. When complete, the Toolkit will enable end-users to run integrated assessments of catchment response to change. For instance, users will be able to see the myriad of effects of changing land use, including changes to flow regime, salt, sediment and nutrient budgets and impacts on riverine ecologic values.

Our third integration objective is more of an operational one, concerning how we go about delivering our integrated knowledge and products to end-users. Whilst the first two challenges outlined thus far are pretty tough, we regard the adoption challenge as our greatest and most important one. In our view, it is no use doing great research if you fail to pay heed to end-user needs and equip them with the ability to apply the know-how you have developed. Hence, virtually everything we do in our Centre is underpinned by an adoption objective. To get adoption we need to integrate the varied elements of our delivery strategy. In planning our new project portfolio we ensured that each research project interacts closely with our Communication and Adoption (C&A) and Education and Training (E&T) programs. These two programs represent the 'backbone' for delivering our products to end-users, but it is essential that each research project is 'plugged into' our delivery strategy via these programs. Our CRC has always been strong on delivery, but we will be even stronger now given the effort we've made in defining key C&A and E&T objectives for each of our new research projects.

A CRC devoted to end-user needs

As I've mentioned in an earlier *Catchword*, one our recent innovations has been to launch a set of 'Development Projects'.

The intent of these projects is to:

(i) build the capacity within our Industry Parties to apply the CRC's modelling tools,

(ii) demonstrate the utility of the tools by applying them to a range of problems at whole-of-catchment scale, and

(iii) provide our researchers with feedback from end-users on the suitability of the models for operational use.

CRC for Catchment Hydrology Focus Catchments

Our goal is to operationalise the models so that they can be applied routinely across the country without direct assistance from the research teams that developed them. Our new project portfolio includes five Development Projects; one for each of our focus catchments. Each of these is run by the relevant Focus Catchment Coordinator, all of whom are based within Industry Parties. Our Industry Parties have made a huge commitment to these projects, providing almost $1 million of additional resources to make them happen. Each Development Project will be guided by a stakeholder reference group, to ensure that a broad-based constituency influences what we do.

Of course, we will be tackling the adoption challenge in other ways too. Through our C&A and E&T programs we will be producing reports, delivering web sites, giving seminars and special briefings, contributing modelling content to undergraduate and postgraduate courses, and running training workshops for model users. In the case of this latter activity, end-users will have ample opportunity over the next three years to receive training in the use of the CRC's Catchment Modelling Toolkit. Through future issues of *Catchword* we will keep you posted on what will be a dynamic training program.

In the meantime, I would like to wish you all a safe and joyous festive season.

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THE YARRA FOCUS CATCHMENT

by GRAHAM ROONEY

The Yarra Catchment

The Yarra River rises in Victoria's Great Dividing Range and flows 245 kilometres to reach Port Phillip Bay at Newport. Its catchment area is more than 4,000 square kilometres, of which about 1,500 square kilometres is urbanised. More than 1.5 million people live within its boundaries. Melbourne Water and the Department of Natural Resources and Environment manage the Yarra River and its major tributaries with local government municipalities managing the smaller tributaries. These stream systems comprise over 5,000 kilometres of piped, channellised, rural and natural channels. The Port Phillip and Western Port Catchment Management Authority coordinates priorities and work programs.

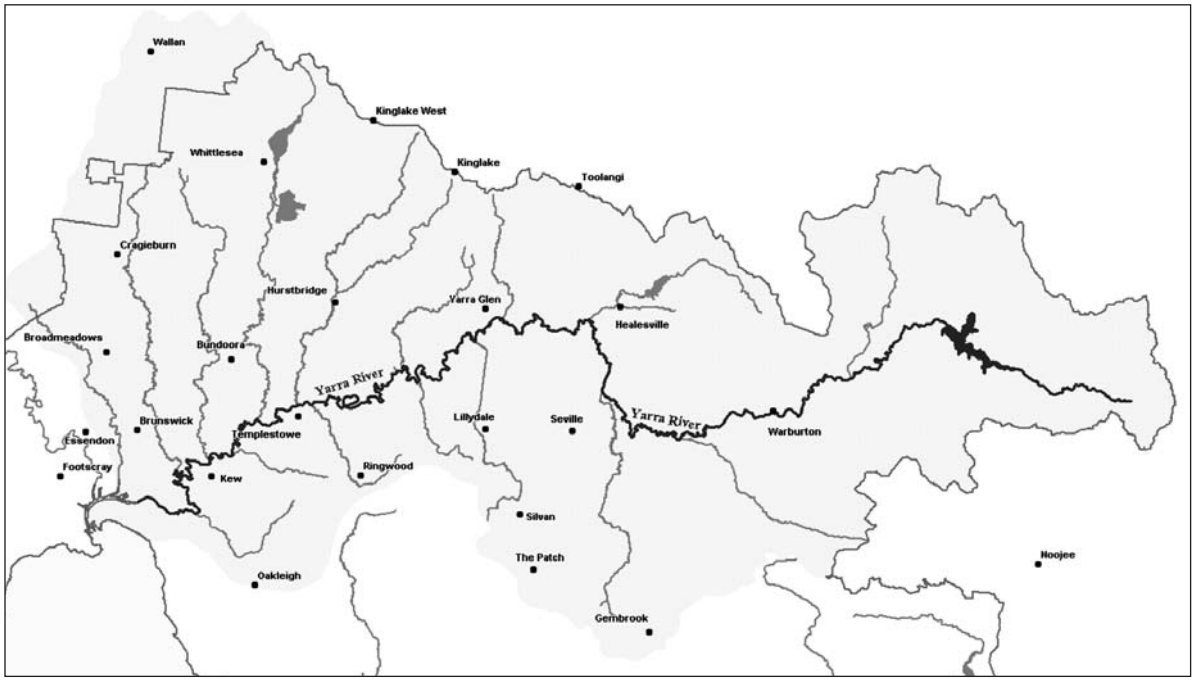
The Yarra catchment was targeted as a focus catchment by the CRC for Catchment Hydrology to demonstrate the application of its research outcomes to address a number of land and water management issues.

Catchment Issues

Years of European settlement have led to issues that are not unique to the Yarra River system, including:

- Compromised stream-water quality and ecosystems resulting from extensive clearing, loss of riparian vegetation and introduction of agricultural land uses; loss of biodiversity and channel capacity due to weed invasion including intentional planting of willows
- Reduced natural flow regimes due to diversions and off-stream storage for irrigation purposes and drinking water; worsening of stream water quality due to rapid spreading of urbanised areas
- Loss of in-stream habitat due to past stream-management practices and lack of riparian vegetation; excessive nitrogen carried in stormwater to Port Phillip Bay threatening its long-term health; loss of migration pathways for native fish due to fish barriers
- Closure of Port Phillip Bay beaches due to occasional bacterial contamination from diffuse stormwater sources and human sewage
- Excessive litter in streams and on Port Phillip Bay beaches as a result of apathy and carelessness.

CRC research is assisting to address many of these issues. The current CRC research Programs on Urban Stormwater Quality and River Restoration focus on stream restoration and urban stormwater issues and the development of tools to support the selection of best management practices.



Yarra Catchment

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

The Last Twelve Months

The grand CRC vision is to predict catchment behaviour. The CRC's Catchment Modelling Toolkit is intended to provide the means to achieving this vision. One component of that toolkit is MUSIC (Model for Urban Stormwater Improvement Conceptualisation). Many Melbourne Water staff were extensively involved in the beta testing of MUSIC and are now regular users of Version 1released in may this year. MUSIC evaluates the impact of land development on water quality in urban streams with an emphasis on optimum location of treatment measures to improve suspended solids, phosphorus and nitrogen levels in stormwater. CRC research at Lynbrook Estate in south east Melbourne has provided data that have been converted into parameters used within the MUSIC software. As a result, bioretention trenches have emerged as potentially effective stormwater-treatment devices in removing nitrogen.

Other CRC Programs have generated improved software that assists in designing rock-chute structures and fish-ways. Stream management staff in Melbourne Water are currently trialing the former. Research into the rehabilitation of sand-slug streams has also led to a better understanding of the importance of habitat structures that not only provide substrate for refuge, but also lead to scour and creation of further habitat.

Important links between CRC for Catchment Hydrology and CRC for Freshwater Ecology researchers have also developed further over the last year. Ecologists have established relationships between land-use and impacts on stream ecology and chemical and biological processes within streams. These findings have led to further exploration of urbanisation impacts through the CRC for Freshwater Ecology Project 'Urbanisation and ecological function of streams'.

Freshwater Ecology researchers based at Monash University have formed links with other CRC for Catchment Hydrology researchers involved in the Urban Stormwater Quality and River Restoration programs. This cooperative research is investigating what are believed to be the two crucial determinants of ecosystem health in streams flowing through urbanised catchments:

- percentage impervious area, and
- connection of the drainage system with receiving streams.

The Yarra River upstream of Melbourne's CBD - subject to the impacts of urbanisation

Applying the CRC's knowledge – the Yarra Development Project

The CRC has developed several products to address a number of catchment modelling issues including runoff generation from rainfall, flow routing, pollutant generation and transport, and land-use impacts on in-stream water quality and ecosystem response.

The Environmental Management Support System (EMSS), developed for the Brisbane River and its catchment, estimates the daily runoff and pollutant loads from 180 south east Queensland region catchments which drain through the river network and into Moreton Bay. The Yarra Catchment Development Project proposes to re-apply the capability of the EMSS tool and develop a whole-of-catchment model for the Yarra catchment's rural area.

The major outcome of the Yarra Development Project will be the ability to predict river water quality at the lower end of the rural Yarra River. This is important because river water is extracted from this site, at Yering Gorge, and transferred to Sugarloaf Reservoir. Although the water is eventually treated, there are risks associated with the quality of raw water from the Yarra River, especially nutrients, bacteria and agricultural chemicals.

The proposed Yarra catchment model will allow simulation of changed land-uses, restored riparian zones, point-source discharges and catchment and river-system hydrology so that the potential water quality for transfer to the Sugarloaf Reservoir may be estimated. Water quality characteristics that will be targeted for modelling are total phosphorus, total nitrogen and suspended solids. Additional characteristics will be considered for inclusion as they emerge from the CRC's second round of research projects commencing January 2003.

Specifically the objectives of the Yarra Development Project are to:

- Build a water-routing and sediment, phosphorus and nitrogen simulation model for the Yarra River catchment based on EMSS and SedNet
- Apply the model, and evaluate scenarios in order to inform decisions about effects on water quality from Yarra basin land-use changes
- Enhance catchment modelling capacity within Melbourne Water and the Department of Natural Resource and Environment, Victoria.
- Prepare client stakeholders for future CRC Toolkit products
- Provide a modelling platform that can be used as the basis for incorporating additional models emerging from the CRC Toolkit.

Melbourne Water is expecting several benefits from this development project. There is the potential for a reduced need for water treatment at Winneke Treatment Plant (below Sugarloaf Reservoir), a real focus on catchment and riverine works to improve Yarra River water quality and a greater understanding of sustainable water-resource allocations. The Yarra Development project represents a means to engage in more holistic water cycle management, where information can be gleaned and decisions made about drinking water quality, stream water quality and ecosystem response from the one catchment-simulation product. We are slowly moving towards real integrated catchment management.

User's experience in implementing the CRC's toolkit models and modules will be passed back to the integration and toolkit researchers as part of an ongoing feedback cycle. This relationship will improve the development of toolkit products and their application in Yarra catchment.

The Next Twelve Months

Development of the Yarra River simulation model will commence in January 2003. Most important of all, we have to build an in-house modelling skill-base. There is no point in having this wonderful toolkit that enables real decision support features if no one is capable of using the software. In addition, there are many stakeholders who are greatly interested in being involved with this project. Identifying and selecting stakeholders to participate in the project team will be important for future successful dissemination of CRC knowledge and adoption of CRC products.

In parallel with the Development Project, the CRC's research team will continue to investigate pollutant-transport processes and the use of landscape features to intercept pollutants prior to entry to streams. The research will assess physical measures, such as modified riparian strips' ability to reduce pollutants to streams.

Alternatives to wetland systems for water quality improvement such as roadside buffer strips, grassed swales and bioretention trenches are also being investigated. Not only will these research outputs lead to an improved parameter data set for the MUSIC model, but a separate project has been initiated to refine the user environment for the MUSIC software.

Further research has been commissioned on stream rehabilitation. This research is establishing preferred techniques for waterway rehabilitation by means of riparian vegetation, reintroduction of large woody debris, and the performance of fish-ways. Priority-setting tools will be developed that will consider ecological outcomes, not just the hydrological and physical aspects.

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An estuarine reach of the Yarra River

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

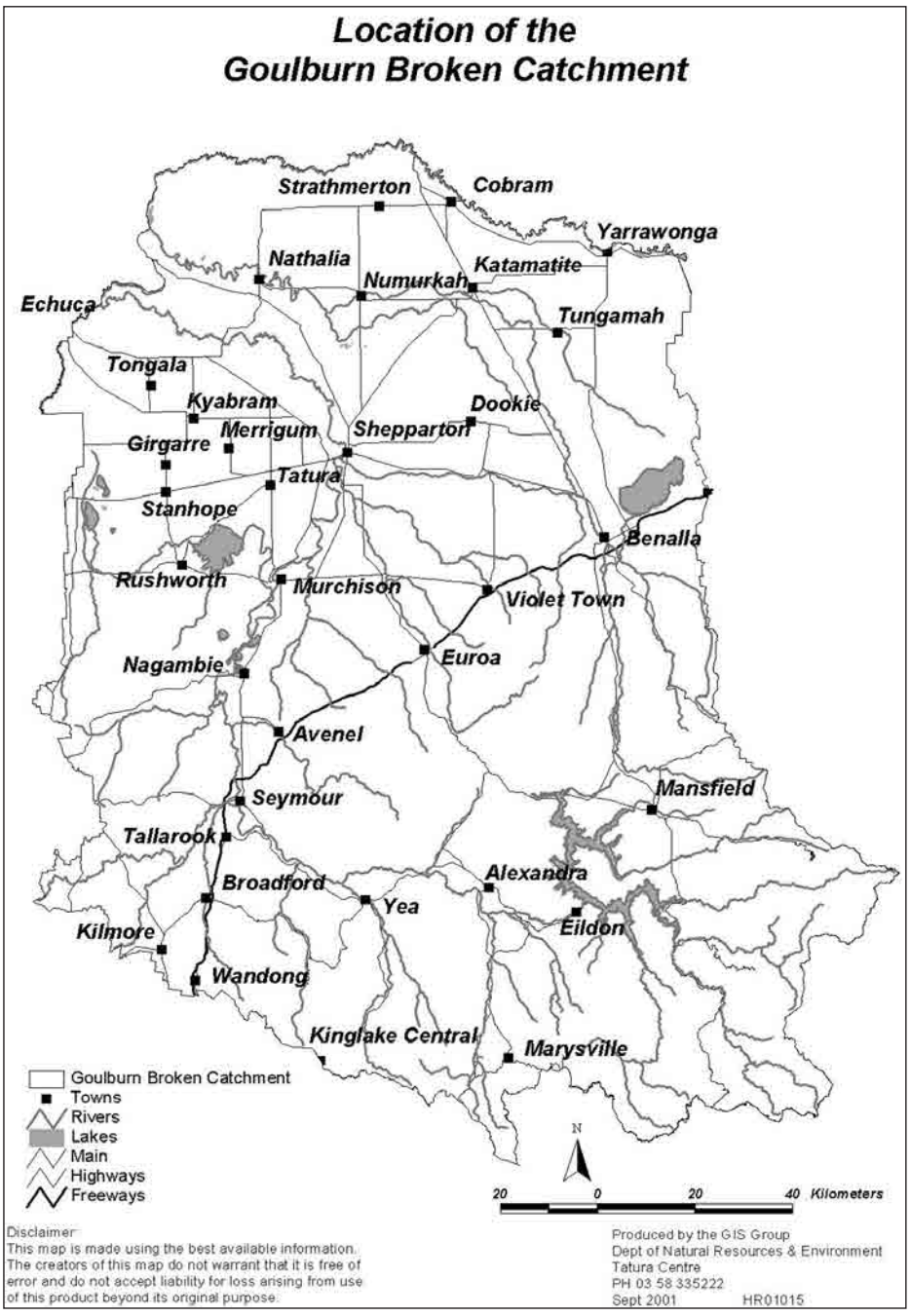
THE GOULBURN BROKEN FOCUS CATCHMENT

by PAT FEEHAN

The Goulburn Broken catchment is home to 189,500 people and is regarded by many as the "food bowl" of the Murray Darling Basin. The region's agriculture output is estimated to be worth $1.35 billion per year and this supports a regional economy that has an annual economic output of $7.8 billion and employs approximately 77,000 people.

This strong performance is due to the region's abundant natural resource assets. The way in which the catchment's water, land and biota assets are managed is critical to the future sustainability of the region and its community.

The Goulburn Broken catchment was included as a focus catchment for the CRC for Catchment Hydrology as part of the Centre's program of research to tackle land and water management issues.



Goulburn Broken Catchment

Catchment Issues

In the Goulburn Broken catchment there are five main issues of concern to catchment managers, irrigators and the local community. These are:

- water quantity
- water quality
- nutrients
- water allocation
- river restoration

The Goulburn Broken Catchment Management Authority (CMA) leads an integrated approach to the protection and enhancement of the catchment's land and water resources. Working with its catchment partners, including Goulburn-Murray Water, Goulburn Valley Water and the Department of Natural Resources and Environment (NRE), the CMA is implementing its Regional Catchment Strategy. Where necessary, detailed strategies to address key management issues such as salinity, water quality, native vegetation have been, or are being, developed.

The Goulburn Broken CMA's Regional Catchment Strategy can be found at www.gbcma.vic.gov.au Further information about the CRC's Goulburn Broken focus catchment and relevant issues can be found on the CRC's web site www.catchment.crc.org.au

Aerial view of a channel and irrigated land in the Goulburn Broken catchment

How is the CRC tackling these issues?

The CRC's research programs have direct relevance to Goulburn Broken catchment issues. Some examples include:

Program 2 – Land-use Impacts on Rivers

Work in Project 2.3 concerning the impact on changes of vegetation cover on the catchment has given us some important insights to the future of the rivers in this region.

Firstly, when grazing land is converted to forested areas in the wetter parts of the catchment, the reduction in stream flow is significant in terms of annual average water yield. Secondly, the impacts on streamflow are greatest in dry periods when streamflows are already low. Finally, when likely afforestation scenarios are implemented, there are significant implications for water security in water allocation models.

The CRC's work enables prediction of the impacts of broad scale vegetation pattern changes with a high degree of confidence. This work complements local predictive capability being developed by the Department of Natural Resources and Environment group at Rutherglen, led by Craig Beverly.

The CRC's work on surface hydrology has been coupled with the salinity models developed by Dr Glen Walker and his team under the Catchment Categorisation for Dryland Salinity Initiative. In the near future this will enable catchment managers to target revegetation to parts of the Goulburn Broken so that salinity control benefits are maximised and the reduction of stream flow is minimised.

Program 3 – Sustainable Water Allocation

Water trading is evolving at a rapid pace. Recently, Goulburn-Murray Water (GMW) introduced Watermove, an on-line system for trading water entitlements. Over the last 18 months the CRC has been developing *Mwater*, a water market modelling system by which farmers, given a model farm, can learn how markets operate. It provides policy makers a way to examine policy options under laboratory conditions and compare predicted outcomes with direct observations of economic behaviour. Experimental methods can be used to test formal economic theory and make practical assessments of economic policy.

In the Goulburn Broken catchment, *Mwater* has been used to examine alternative ways for auctioning new groundwater entitlements and for assessing the impact of alternative forms of water market information.

As part of the development of *Mwater*, three workshops have been held in the catchment with farmers and GMW staff. The feedback has been extremely positive and the project team is currently looking at ways of making it more readily available for farmers and staff to use.

In the next round of projects the CRC will be exploring the application of *Mwater* to water policy issues such as

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).

unbundling property rights, water pricing and environmental flows, and establishing free water trading sessions for farmers.

Margot Biggin, a postgraduate student with the CRC based at Monash University, has commenced her research in the Goulburn Broken catchment. Margot is developing a simple procedure for evaluating the environmental consequences of water allocation decisions and incorporating this procedure into a water allocation model. Water management within the catchment is being used as a case study for her PhD research.

Program 5 – Climate Variability

The Climate Variability Program is delivering several tools that are relevant to catchment issues. The stochastic models developed in the Program provide techniques for quantifying the uncertainty in hydrologic systems caused by climate variability. Models for generating stochastic rainfall and climate data for a point location and at a daily time scale are already available. The Program is now concentrating on developing models for generating spatial rainfall data.

The Program has also developed a model that exploits the serial correlation in streamflow and the ENSO-streamflow relationship to forecast reservoir inflows several months in advance. The forecasts, which are expressed as exceedance probabilities, can be used as inputs into the Goulburn Broken catchment models to estimate the likelihood of increases in water allocations in the coming months.

There is also potential to use the Bureau of Meteorology's Numerical Weather Prediction (NWP) Models and rainfall fields from radar imagery analysis to assist operational water management. The Climate Variability Program is currently incorporating irrigation data from the Goulburn Broken in the NWP models to provide more realistic forecasts of rainfall and potential evapotranspiration. These forecasts can be used to guide water releases from reservoirs.

Program 6 – River Restoration

The River Restoration Program has undertaken a number of projects in the Goulburn Broken catchment.

In one of these, researchers have examined the physical response of two tributary streams (Castle and Creightons Creeks) to placement of logs across the channel. Results to date look promising and the woody debris has resulted in larger than expected scour holes. However, more significant flows are required to assess whether larger scour holes are formed, as predicted, and to assess the ultimate impact on fish communities. This stream restoration experiment has been undertaken in partnership with the CRC for Freshwater Ecology and the Goulburn Broken CMA.

In another project, Mike Stewardson applied the Flow Events Method (developed in Project 6.7) to assess the environmental flow requirements of the Broken River. This project has lead to wider adoption of the method within Victoria. The flow recommendations have been under consideration by the consultative committee set up to oversee the bulk water entitlements process.

Fishway incorporated into a replacement weir on Broken Creek

Mike Jensz is undertaking a Masters degree at The University of Melbourne and is using the flow events method to assess the effects of flow regime on primary production in the Broken River. This is a collaborative research effort with the CRC for Freshwater Ecology, in particular, Ben Gawne and others at the Murray Darling Freshwater Research Centre.

Applying this knowledge in the catchment – the Goulburn-Broken Development Project

Over the past six months the Goulburn Broken Development Project has been established by the CRC. The project, entitled *'Modelling and managing land-use impacts in and around water storages in northern Victoria'*, was approved by the CRC's Board in November 2002 and the project is now under way.

Background

Goulburn-Murray Water manages a number of large water storages scattered across northern Victoria. Water from these storages is used for a variety of purposes, principally irrigation, but also for urban water supply, stock watering, commercial and recreation

(contact and non contact with water). The use of this water supports a substantial rural economy.

As noted, organisations involved in water and catchment management have a number of water quality and quantity issues and concerns in catchments and around major water storages. Particular concerns include pathogens, turbidity and sediment, blue green algae and nutrients, salinity and land-use and climate change impacts on water yield.

Land management and development activities in catchments may be having an adverse impact on water quality and quantity in storages. Improved management of these activities, especially in the proximity to storages, is needed.

Water storage managers are asking questions such as:

- What land-uses and developments, and at what location, should we be concerned about?
- Should we be renewing leases around storages - under what conditions?
- What happens to pollutants in the catchment - what happens to them in storages? - Where do they come from - can they be managed?

These are integrated catchment management issues and the CRC is developing integrated catchment modelling tools (remember the CRC's Mission - *"to deliver to resource managers the capability to assess hydrologic impacts of land-use and water management decisions at whole of catchment scale")*. The Goulburn Broken Development Project gives resource managers a great opportunity to apply and test the CRC's modelling tools to real life situations.

Project objectives

A number of the CRC's modelling tools will be applied and evaluated in two case study catchments to help managers to:

- Predict sources, transport and land-use impacts of pathogens, sediment, nutrients, turbidity and salinity
- Predict and manage land-use impacts on catchment yield and water quality
- Use the modelling process to engage with catchment stakeholders, and
- Develop catchment management recommendations to reduce land-use impacts on water quality and quantity.

A longer-term aim is to develop regional expertise to enable similar modelling applications to be rolled out over GMW's entire region in northern Victoria, and hopefully, other parts of the State as well (The Yarra Development Project will also contribute to this aim).

The CRC's capabilities will be utilised and further developed in predicting land-use impacts on pollutant delivery and transport (for example, sediment, nutrients, turbidity and salinity) and water yield. These predictive tools will be progressively integrated during the course of the project, based largely on the current EMSS (Environmental Management Support System) model interface.

Outputs from the selected modelling tools will be compatible with existing reservoir simulation models, eg CAEDYM – DYRESIM and CAEDYM – ELCOM, to enable the modelling of within-storage movement of pollutants (work to be done by others). As well as helping understand the within-storage fate of pollutants delivered from the catchment, this modelling will help with assessing the impact of water activities such as recreation and houseboats.

Case Study Catchments

The Goulburn Broken Development Project will be undertaken in two areas:

- the Upper-mid Goulburn catchment including Lake Eildon (catchment size 3535 sq km) and Goulburn Weir (catchment size 10627 sq km)
- Tullaroop Reservoir in the Loddon River catchment (catchment size 722 sq km).

The upper-mid Goulburn catchment has been chosen because of concerns about development and recreation issues, business risk, and concerns about water quality (pathogens, nutrients and blue green algae). Lake Eildon is the major water storage on the Goulburn System and is capable of storing 3,390,000 ML of water for irrigators and towns across northern Victoria. Water released from Lake Eildon is diverted to these areas at Goulburn Weir, near Nagambie.

Tullaroop Reservoir has been chosen because of concerns about drinking water quality, nutrients (and sediment), blue green algae, and salinity. It is located on the Loddon system, near Maryborough, has a capacity of 74,000 ML, and experiences major blue green algal blooms. It supplies irrigation water to the Loddon system and urban water to the town of Maryborough.

Although the Tullaroop catchment is not in the Goulburn Broken Focus Catchment, it presents a range of water issues of great interest to GMW and also provides a

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).

contrast in scale to the much larger Upper-mid Goulburn catchment.

Both catchments are proclaimed as Special Water Supply Catchments under the Victorian Catchment and Land Protection Act.

GMW will manage the Goulburn Broken Development Project for the CRC with substantial technical input provided by NRE and the Centre for Land Protection Research (CLPR), and other CRC participants.

Work in the next 12 months

Over the next twelve months the team will carry out a number of key tasks. Most importantly, the project team will have to develop its capability to construct catchment models (with the cooperation of the Centre for Land Protection Research at Bendigo), assemble relevant data sets, and then start building models using the CRC's tools.

Once this has been done, work on exploring management scenarios can begin.

Community group involvement and action plays a significant role in managing the land and water resources in the Goulburn Broken catchment.

To help ensure broader community understanding of the project, a Stakeholder Reference Group has been set up to advise on the conduct of the project. This Group involves representatives of key stakeholders interested in catchment and reservoir management, including Catchment Management Authorities, municipalities, recreation, user and business groups.

From a Focus Catchment Coordinator's perspective there are a number of great things about the concept and delivery of Development Projects. Some of these include:

- Strong support of the CRC (and some pretty good brains) in developing local solutions to our issues
- Access to the most up-to-date modelling tools available
- Developing and building a regional capacity to utilise the CRC's modelling tools into the future
- Raising researchers' awareness of the local and regional catchment issues for which they are developing tools.

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THE MURRUMBIDGEE FOCUS CATCHMENT

by CAROLYN YOUNG, PETER HAIRSINE, FRANCIS CHIEW, TIM ELLIS, JOHN TISDELL and BILL YOUNG

Introduction

In the October 2001 *Catchword* article on the Murrumbidgee Catchment a CRC Focus Catchment, we gave an overview of the catchment features and the research outcomes desired by the local community. We also discussed how the CRC is attempting to tackle some of the issues faced by natural resource managers in the Murrumbidgee Catchment.

Since October 2001, much planning and research has taken place in the Murrumbidgee Catchment. In terms of planning, the Murrumbidgee Catchment Management Board has produced the draft Catchment Blueprint. In this article we will briefly visit the key issues identified in the Blueprint; these issues and their associated targets will focus natural resource management in the catchment over the next ten years.

As the first round of CRC projects come to a close, it is now appropriate to review some of the research findings in the context of the Murrumbidgee Catchment, particularly the decision support tools and advancements made in our knowledge of how catchments work.

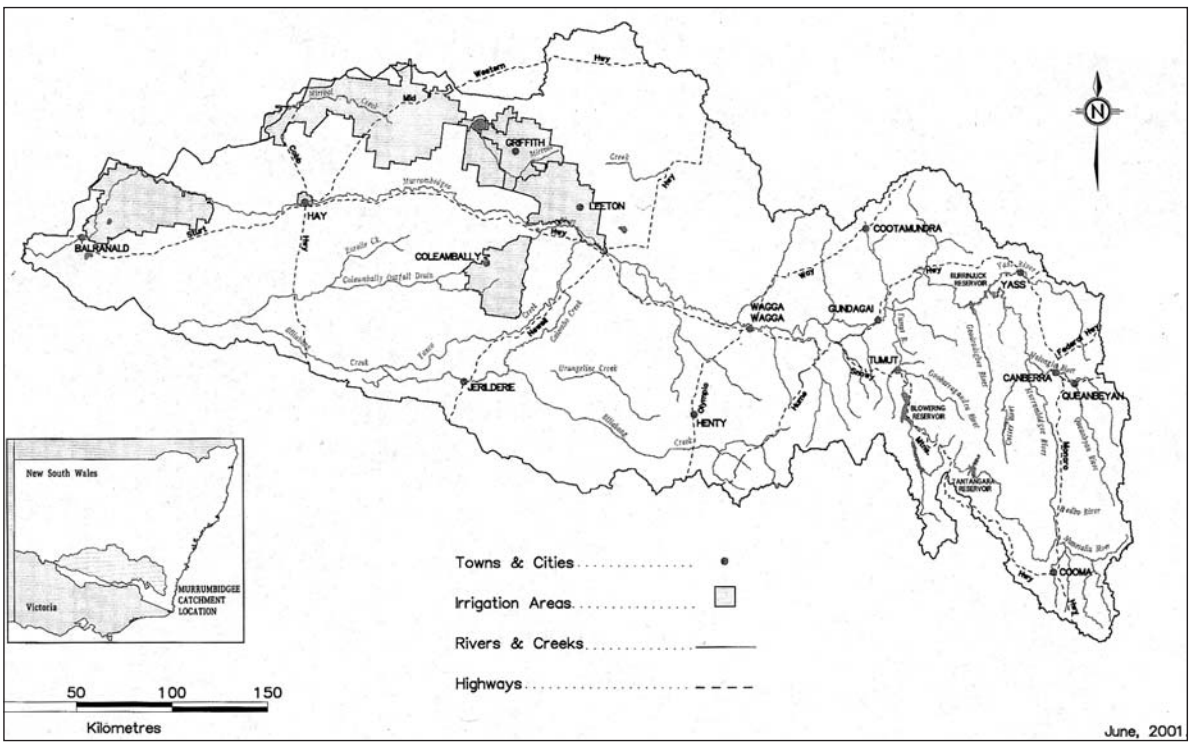
The second round of CRC projects commences in January 2003 - these include Development Projects - an exciting new method of facilitating adoption of research products. This article concludes with a brief overview of the Murrumbidgee Development Project – to provide a taste of what's in store.

Overview of issues in catchment

The Murrumbidgee Catchment Management Board aims to improve the management of natural resources within the Murrumbidgee Catchment and its 'Blueprint' establishes priorities for funding and research. The Blueprint is the result of some two years worth of consultation involving community, industry, interest groups and governing bodies.

The major natural resource management issues and objectives in the catchment as identified in the draft Blueprint Catchment (2001) are:

- Water quality and flow – improve water quality and regulate river flow for the needs of both the community and the environment;
- Salinity – increase the area of deep rooted perennial pastures and trees in the catchment, and reduce saline seepages to streams which eventually enter the Murrumbidgee River;



Murrumbidgee Catchment

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).

- Soil health – improved soil management through management actions such as maintaining groundcover, treating acid soils, and promoting perennial pastures;
- Biodiversity – protect and enhance the priority native vegetation types and so improve the biodiversity of the catchment; and
- Social/cultural – better inform the Murrumbidgee community on natural resource management and so develop a culture of environmental stewardship.

The Blueprint has draft catchment targets aimed at dealing with the issues outlined above. Those targets specifically relevant to the CRC's research interests are:

- Improved water quality in the Murrumbidgee River and its main tributaries by reducing suspended sediment levels;
- Reduced salinity levels in the Murrumbidgee River to meet the NSW Salinity Strategies 'end of system' salt targets at Balranald; and
- Sustainable land-use throughout the catchment.

The Blueprint will be operational for a period of ten years after it is approved, with a major review five years after its commencement.

CRC outputs and products related to principal issues

Water quality

As regional communities in the Murrumbidgee and elsewhere across Australia decide how best to meet water quality targets for their rivers, they need to identify and control the major sources of sediment and nutrients that affect water quality.

CSIRO Land and Water in conjunction with the CRC and others have developed methods that:

- Predict river sediment and nutrient loads
- Identify the major sources of sediment and nutrients, and
- Show how those sediment and nutrient loads might change with different management.

SedNet and EMSS

These methods are currently packaged in two software programs, SedNet and EMSS, which Ian Prosser and Rob Vertessy respectively have discussed in previous editions of *Catchword*. SedNet and EMSS were developed for different purposes, but are now being linked as part of the CRC Toolkit. A nutrient and sediment modelling package has direct application in the current planning environment in the Murrumbidgee Catchment, particularly to the water quality targets. The proposed application of these models is outlined in the description of the CRC's Murrumbidgee Development Project at the end of this article.

For more information on SedNet and EMSS contact:
Ian Prosser ian.prosser@csiro.au
or Rob Vertessy rob.vertessy@csiro.au respectively

Pathways

Soil eroded from upland farming areas is a significant pollutant of streams in agricultural regions. Land managers can influence soil erosion levels through management of soil surface condition (e.g. tilled, not tilled) and soil cover (e.g. crop stage, stubble retention). There is also an opportunity to influence the trapping of eroded soil (mobilised as suspended sediment) before it leaves the hillslope and reaches the stream.

Cropping farmer liming paddocks in the Murrumbidgee to address soil acidification and improve soil structure.

Typical farm runoff/erosion control structures (e.g. contour channels, filter strips and water ways), not only reduce erosion, but also trap significant amounts of suspended sediment before it leaves the hillslope. There is a need to better understand the role of these structures in trapping suspended sediment so their design and layout can be optimised.

In Project 2.2, as part of the Land-use Impacts on Rivers Program, Peter Hairsine (CSIRO Land and Water) and others have developed a new hillslope-scale model (known as 'Pathways') for estimating the deposition of suspended sediment, the re-entrainment of deposited material, and the sorting of coarse and fine sediment down the flow paths. Pathways is currently being evaluated by Tim Ellis (CSIRO Land and Water) using field data and will be used to estimate the influence of runoff/erosion control structures on the delivery of sediment from farm hillslopes to streams.

Following evaluation, the Pathways model will be used in four ways:

- Informing non-scientists (e.g. farmers, consultants, extension officers) regarding the value of erosion control structures for preventing suspended sediment reaching the stream;
- Investigating the potential for improved design and layout of runoff/erosion control structures to minimise suspended sediment reaching the stream;
- Providing better estimates of sediment delivery ratios for specific land management practices (e.g. cropping, grazing), and soil types, for input to catchment scale sediment routing models such as SedNet; and
- Investigating the potential for tracking the accumulation and export of specific pollutants that accompany specific soil particle sizes.

Pathways is being built using ICMS (the Interactive Component Modelling System), one of the frameworks promoted by the CRC's Project 1.1 Toolkit team.

For more information, contact:
tim.ellis@csiro.au or peter.hairsine@csiro.au

River habitat

CRC Associated Project 2.14: 'Improved methods for targeting river restoration works' (with core funding from the Natural Heritage Trust) - is providing better ways to prioritise river reaches for rehabilitation by identifying reaches where the instream physical habitat is currently degraded by sedimentation, but which also have a high recovery potential because of higher slope and/or discharge. The results of the research could assist in defining new activities under the water management action *"Enhance fish habitat"* agreed to in the Catchment Blueprint.

The project has used field data and spatial modelling of sediment budgets (based on catchment disturbance) to develop statistical models that predict the occurrence of reaches impacted by excessive sand deposition, and statistical models that predict the pre-disturbance channel types across the entire river network upstream of Wagga Wagga. River channel types are defined by planform (straight or sinuous), major bedforms (steps, riffles, pools), and bed material size (cobble, gravel, sand). These models have identified reaches that are currently buried in sand, but which were previously cobble or gravel pool-riffle reaches. Rehabilitation of these reaches would restore valuable fish habitat, and their rehabilitation would be less expensive than for lower gradient reaches, because the higher stream energy would assist bedform recovery.

The project has also collected data to investigate the responses of macroinvertebrate communities to differing degrees of sedimentation. However, these data have not yet been analysed.

For more information about this project contact:
Bill Young bill.young@csiro.au

Stock access to riparian areas has implications for water quality.

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

Flow Vegetation changes

Through the Land-use Impacts on Rivers Program, Lu Zhang (CSIRO Land and Water) has been investigating the impact of vegetation cover changes on the Murrumbidgee's flows. Lu has researched the impacts when grazing land is converted to forested areas in the wetter parts of the catchment. He found that the reduction in stream flow is significant in terms of annual average water yield and the impacts on streamflow are greatest in dry periods when streamflows are already low. Likely afforestation scenarios for the Murrumbidgee show that there are significant implications for water security in water allocation models. The CRC's work enables the prediction of the impacts of broad scale vegetation pattern changes with a high degree of confidence.

For more information, contact:
Lu Zhang lu.zhang@csiro.au

Forest operations in the Brindabella ranges

The Climate Variability Program is delivering several tools that are relevant to catchment issues in the Murrumbidgee River Basin (as outlined also for the Goulburn Broken Catchment). A stochastic downscaling model has been calibrated for the Murrumbidgee and can provide stochastic replicates of multi-site daily rainfall at 30 locations for the present climate and 2030 climate.

As noted for the Goulburn Broken Catchment, there is also potential to use the Bureau of Meteorology's Numerical Weather Prediction (NWP) Models and rainfall fields from radar imagery analysis to assist operational water management. As part of this research, an extensive soil moisture monitoring program is being carried out at 18 sites across the Murrumbidgee (with five sites concentrated on each of the Kyeamba Creek and Adelong Creek catchments). The data will be used for testing hydrological models, in particular the land surface model used in the NWP models.

For more information, contact:
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Salinity

The CRC's Land-use Impacts on Rivers Program work on surface hydrology has been coupled with the salinity models developed by Dr Glen Walker and his team under the Catchment Categorisation for Dryland Salinity Initiative. In the near future this will enable us to target revegetation to parts of the Murrumbidgee Catchment so that salinity benefits are maximised and the reduction of stream flow is minimised. This complements the NSW Department of Land and Water Conservation (DLWC) tools, and will be further explored in the new Project 2C: 'Predicting salt movements through catchments', led by Mark Littleboy.

For more information, contact:
Mark Littleboy mlittleboy@dlwc.nsw.gov.au

Irrigation management

Farmers in the Murrumbidgee catchment have been actively involved in a series of water market experiment workshops held at Yanco Agricultural Institute over the last 18 months. These workshops involved farmers managing irrigation farms and when appropriate, trade water entitlements in a temporary market. Like all irrigation farmers they face uncertain rainfall, decisions on whether to grow an irrigated crop each season, what volume of allocation to use each month given watering demands latter in the season, and whether to reduce the area of land irrigated if water is short. At the same time, options to buy and sell water entitlements exist in a monthly temporary market where the volume traded and market price varies according to supply and demand.

Aerial view of the Leeton irrigation canal

In this environment, the consequences of alternative auction structures – such as open call where the traders see all the bids as they are lodged in the market – have been explored. More recently a group of experienced farmers have been involved in a series of experiments exploring the conditions necessary to promote group management of environmental flow requirements.

For more information, contact:
John Tisdell j.tisdell@mailbox.gu.edu.au

Murrumbidgee Development Project

Development projects provide an opportunity to demonstrate the utility of the CRC's integrated, whole-of-catchment-scale modelling capability. In the case of the Murrumbidgee Development Project, integrated nutrient and sediment modelling capability will be applied (i.e. an evolution of SedNet and EMSS). The project will make operational the CRC sediment and nutrient modelling products within DLWC. This capability will enable DLWC to model sediment and nutrients for the Murrumbidgee Catchment Management Board water quality target, provide technical input to refine the water quality targets (currently in draft form) and also guide investment in the catchment. Should the project be a success in the Murrumbidgee, DLWC has the option to roll-out the capability to other catchments across NSW.

The project commences in January 2003 and will run for 18 months. It is anticipated that the project will provide:

- An operational sediment and nutrient modelling package for the Murrumbidgee Catchment which estimates the:

  - Temporal variation of total suspended solids, total nitrogen and total phosphorus at target sites in the Murrumbidgee Catchment; and

  - Spatial patterns of the sources, sinks and outputs of sediments and nutrients in the Murrumbidgee Catchment;

- A user guide describing how to use the sediment and nutrient modelling package for the Murrumbidgee. This will complement the general user guides available with the software;

- Training workshops for DLWC model users;

- A knowledge transfer workshop for DLWC staff analysing and interpreting the model outputs; and

- An expert panel workshop to refine the Murrumbidgee water quality target.

For more information contact:
Carolyn Young
Murrumbidgee Focus Catchment Coordinator
Email: cyoung@dlwc.nsw.gov.au
Tel: 02 6298 4020

Reference
Murrumbidgee Catchment Management Board (2001). Draft Murrumbidgee Catchment Blueprint 2001. See http://www.dlwc.nsw.gov.au/care/cmb/blueprints/index.html for a copy.

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).

THE BRISBANE FOCUS CATCHMENT

by TONY WEBER

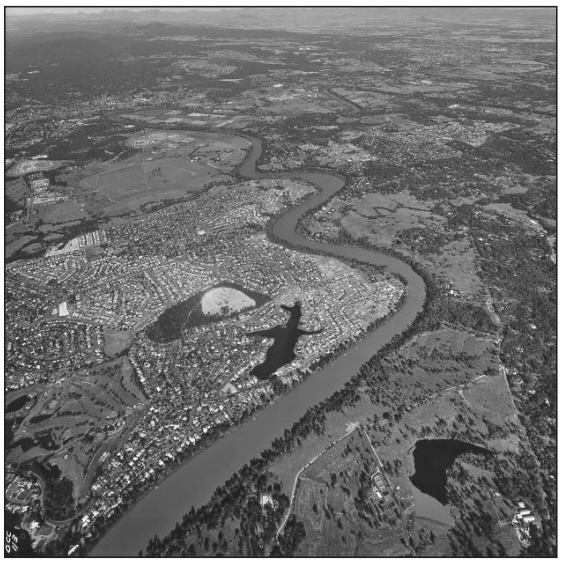
Catchment Overview

The Brisbane River Catchment is the largest river system in the South East Queensland region, draining an area of 13,500 km^2. The catchment is bounded by the Great Dividing Range in the west and drains into the sensitive environment of Moreton Bay. Annual rainfall for the region is in the order of 1500 mm, mostly falling as intense summer storms. Land-use within the catchment is dominated by agricultural uses such as cropping and grazing in the west and urban uses in east. Some 14% of the catchment remains uncleared.

Within the catchment, the Brisbane River is the major waterway and provides a variety of valuable services to the South East Queensland region, including irrigation water and potable water supply, recreation opportunities, flood conveyance and ecosystem functions. These services support a population in excess of 2 million (63% of State total) and population growth in the region is one of the highest in Australia.

The Brisbane River discharges into Moreton Bay, home to 700-900 dugong and supporting a fishing industry worth over $400M annually. The Bay also plays a major role in the lifestyle of the region's residents and contains several internationally significant habitats for migratory birds.

Given the competing uses and functions of the River and its catchment, issues within the region are typical of most large river systems, but tend to be dominated by the episodic nature of the sub-tropical climate.



Aerial view of the Brisbane catchment looking west showing the rural residential and agricultural lands in the upper reaches of catchment

Key Catchment Issues

At the 2002 CRC annual workshop held at Ballarat, one of the tasks undertaken was the development of a conceptual systems view of the catchment. The issues and impacts below are a synopsis of the results:

Climatic Issues

- Episodic nature (i.e. most rainfall in intense summer storms)

Hydrologic Issues

- Large storages in middle reaches of the Brisbane River
- Insufficient environmental flows due to flow regulation
- Water over-allocation in western catchments
- Flood prone nature of lower reaches (regional and local)

Impacts

- Degradation and loss of riparian vegetation especially in first and second order streams
- Sediment sources and loads (instream erosion dominant within the catchment) resulting in high and persistent turbidity in the lower Brisbane River
- Nutrients from point sources account for the majority of the load to receiving waters
- Phytoplankton and cyanobacteria blooms in Moreton Bay
- Relatively poor ecosystem health in the majority of streams and the Brisbane River.
- Sensitivity of the receiving environment (dugong and migratory bird habitat)
- Local and regional impacts from stormwater runoff and sewer overflows in urban areas
- Salinity in the western agricultural areas (focus area for the National Action Plan for Salinity and Water Quality)
- Socio-economic and ecosystem valuation and response not well understood

CRC Research within the Catchment

Regional Water Quality Management Strategy

A prime focus within the catchment over the last several years has been the development of the comprehensive

The Brisbane River forms an important part of Brisbane's landscape and is the focus of many recreational activities and the Riverfestival.

South-East Queensland Regional Water Quality Management Strategy to address the catchment issues identified above. The Strategy's long term vision is to ensure that "South East Queensland's catchments and waterways will, by 2020, be healthy living ecosystems supporting the livelihoods and lifestyles of people in South East Queensland, and will be managed through collaboration between community, government and industry". Implementation of the Strategy is now the goal of the Moreton Bay Waterways and Catchment Partnership, who are building on existing research outcomes and refining the management tools developed under the Strategy.

CRC Researchers have had an intimate involvement in the development of the Strategy through the provision of contract research. The research has led to several tools being completed by the CRC that are seeing application in the other catchments. Specifically, the development of the Environmental Management Support System (EMSS) for South East Queensland is now being considered as the basis for Development Projects in this and other Focus Catchments. In addition, other tools developed for the Strategy, such as the Local Scale EMSS (LEMSS), will be of benefit to catchment managers throughout the country. Through the application of the EMSS in the South East Queensland region, quantification of catchment loads have helped catchment managers prioritise actions that will have the maximum impact on these loads.

Urban Stormwater Quality Management

Urban stormwater, while not the largest source of sediment within the catchment, still produces a disproportionately high sediment load given the relatively small urban area. As such, Brisbane City Council has placed significant emphasis on the management of urban stormwater in its recently released City Plan. This planning scheme requires developers to demonstrate compliance with locally specific receiving water objectives when planning their developments. The CRC has 'come to the rescue' of both local government and the development industry through the release of the MUSIC (Modelling Urban Stormwater Improvement Conceptualisation) software. This tool allows conceptual design of stormwater quality management practices to be undertaken, with assessment of the compliance with water quality standards or guidelines integrated within the software. Based on the significant interest shown in the Focus Catchment for both the public release of the MUSIC software and the subsequent training in its use, the adoption of the CRC's research in this area has been widespread.

The research undertaken by the CRC within the Focus Catchment has been used to both assist in the development of the SEQ Regional Water Quality Strategy, and to build on fundamental research being undertaken in other Focus Catchments. The CRC's 2001-2002 Annual Report contains descriptions of the research being undertaken on a Program-by-Program basis. Research being undertaken in the Brisbane Focus Catchment is summarised below:

Program 1 – Predicting Catchment Behaviour

- EMSS
  Researchers completed the EMSS, a regional water quality model, which has been applied across south-east Qld to predict sediment and nutrient fluxes through the river network and into Moreton Bay. EMSS is being used by the CRC and catchment stakeholders, including WBM Oceanics, an industry affiliate to the CRC, as part of the Moreton Bay Waterways and Catchment Partnership. Based on the TARSIER framework, the EMSS predicts daily runoff and daily loads of total suspended sediment, total nitrogen and total phosphorous from 180 sub-catchments within the 22,670 km^2 region. Its predictions are sensitive to changes in climate, storage operations, land-use and land management practices, including point and diffuse source loadings and treatments. The EMSS has been designed for use by a range of stakeholders with varying levels of computer and technical proficiency. Three separate component models underpin the EMSS including:

  - a lumped-conceptual rainfall – runoff and pollutant export model
  - a flow and pollutant routing model
  - a model of reservoir storage dynamics

The EMSS structure allows for component models to be easily replaced, and additional ones to be added with minimal effort.

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.

- LEMSS
  A pilot Local-Scale EMSS (LEMSS) was developed. A sophisticated water quality model, the LEMSS also simulates the health of aquatic ecosystems. It has been applied to the Pine Rivers catchment, south-east Qld, to predict the generation of sediment and nutrients and their delivery to Lake Samsonvale and Lake Kurwongbah Reservoirs.

Program 2 – Land-use Impacts on Rivers

- Sediment study
  Findings from a two-year sediment study in south-east Qld are being used to target catchment rehabilitation work in the Brisbane catchment. Using a multi-faceted approach – including analysing existing data, catchment scale modelling and sediment tracing – researchers found gully and stream bank erosion was the dominant form of erosion in the catchments and that 90% of the sediment in estuaries and Moreton Bay came from only 30% of the catchment area, predominantly in the Marburg geological landscape in the upper Bremer and Lockyer catchments. The study, conducted for the South East Queensland Regional Water Quality Management Strategy (SEQRWQMS) demonstrated the benefits of a combined modelling and tracing approach to determine the sources of sediment.

- Riparian zone research
  CRC Project 2.5: 'Nitrogen and Carbon Dynamics in Riparian Buffer Zones' investigated how nitrogen management in catchments impacts water quality in sensitive downstream ecosystems, for example, Moreton Bay, and Port Phillip Bay. Riparian buffer zones can intercept nitrate (an ecologically important form of nitrogen) in shallow groundwater and surface water flows and minimise its delivery to streams. This project involves collaboration between the CRC for Catchment Hydrology and the CRC for Coastal Zone, Estuary and Waterway Management.

  Two distinct groundwater systems have been identified as a result of continuous monitoring at this project's experimental site in the riparian zone of Coochin Creek, which flows into Moreton Bay, south-east Queensland. Groundwater chemistry analyses showed a permanent water table connected to the regional groundwater table as well as a small local perched water table from the stream.

  These insights into water flows through the riparian zone revealed a component of axial flow, where some water flows from the stream channel into the riparian zone and then back to the channel further downstream. This could have important implications for how riparian zones can be managed to reduce stream nitrogen levels.

  The project attracted considerable community interest, in response to two newsletter articles and two field day presentations.

Program 4 – Urban Stormwater Quality

- Wetland study
  Extensive monitoring activities occurring in Bridgewater Creek stormwater treatment wetland. The newly constructed wetland, designed using CRC-developed best practice principles, has undergone extensive water quality monitoring. Automatic samplers have been installed, and both storm event and dry weather samples are being taken. In addition, the CRC is undertaking mapping of the vegetation within the wetland and a survey of biota within and downstream of the wetland, to examine the impacts of the stormwater treatment wetland on downstream ecosystem health.

- Stormwater quality monitoring
  Brisbane City Council (BCC) has, since 1995, undertaken a rigorous stormwater quality monitoring program. This program has been designed to assist Council, and its

Brisbane Catchment

stakeholders, to predict water quality emanating from catchments of different land-use, and to use this for setting stormwater quality targets. The CRC has been assisting BCC to use these data to derive default parameters for application of MUSIC in Brisbane. A preliminary set of Brisbane default parameters have now been established, and will be incorporated into Brisbane City Council's 'Stormwater Quality Modelling Guidelines'.

- SQIDS
  The CRC has been working with BCC to undertake monitoring and field-testing of SQIDS (stormwater quality improvement devices). In 2001, a set of experiments was conducted on a grass swale, at Woodcrest Estate, 15km from Brisbane CBD. A second series of experiments was conducted in 2002, examining the influence of inflow concentration, particle size, and flow rate, on treatment performance. The results of these experiments are being used to refine design guidelines for vegetated swales in Brisbane, and to calibrate predictions of swale performance, using MUSIC.
- PhD work
  A number of PhD projects at Griffith University, supervised by CRC researchers, are being undertaken. David Newton is examining the hydraulic and water quality performance of porous pavements. Despite little previous application of porous pavements in Australia, this technology forms a major component of stormwater management in Europe, and may have real potential for both attenuating peak flows from urban areas, and improving water quality. A second project, being undertaken by Courtney Henderson, is exploring the behavior of bioretention systems in treating urban stormwater. Courtney's project will examine the influence of filter media particle size, vegetation, and hydroperiod, on treatment performance. The project involves both laboratory and fieldwork, and will make a significant contribution to improving the design standards for bioretention systems.

Program 5 – Climate Variability

- Stochastic model
  The stochastic models developed in the Climate Variability Program provide techniques for quantifying the uncertainty in hydrologic systems caused by climate variability. Models for generating stochastic rainfall and climate data at a point down to the daily time scale have been developed. The Program is now concentrating on developing models for generating spatial daily rainfall and point sub-daily rainfall data.
- Space-time rainfall model
  The Program has also developed a space-time rainfall model that can estimate temporal rainfall fields for design storms and a rainfall nowcasting model that can forecast rainstorms one to two hours ahead.

Program 6 – River Restoration

- Riparian revegetation
  Project 6.4: 'Evaluation of Riparian Revegetation in a South-east Queensland Catchment' aims to test the effectiveness of restoring large tracts of riparian vegetation. The focus is on evaluating a stream rehabilitation project in south-east Queensland.

  Stream rehabilitation works have been completed and ongoing maintenance and weed control has resulted in rapid growth of riparian vegetation. Equipment to continuously measure or monitor turbidity, water depth and temperature has been deployed in treatment and control reaches. The monitoring has shown a response to the revegetation strategy, especially with water temperature differences of up to 10^{o}C between vegetated and unvegetated streams.

The South-East Queensland CRC Development Project

The catchments of South-East Queensland (SEQ), including the Brisbane River catchment, all discharge into sensitive tidal estuaries such as Moreton Bay, the Southport Broadwater, Pumicestone Passage and the lower river estuaries of the Noosa, Maroochy and Mooloolah Rivers. Catchment management in the region is undertaken by a variety of groups and agencies, with the Moreton Bay

Aerial view of Moreton Bay. Water quality in the Brisbane River impacts directly on the health of Brisbane's Moreton Bay

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

Waterways and Catchment Partnership taking the strategic management role in the region.

– EMSS focus
With the development of EMSS, a tool now exists that can inform and assist in catchment management decisions and lead to greater consistency in the decision-making process. The SEQ Development Project, being led by the Queensland Department of Natural Resources and Mines (NRM), aims to utilise EMSS as a central focus to building the capacity of catchment groups and agencies within Local and State governments in using predictive tools to inform catchment management decisions.

– Developing partnerships
Additionally, it is hoped to use the project to develop partnerships directly between the government agencies and natural resource management community groups within the region. Using EMSS and other elements of the CRC's toolkit, the project will consider priority areas for management actions or further study and use the models as educational tools to assist stakeholders in their understanding of the complexities of the various catchments.

– Other links
The project will build on previous and current work in applying EMSS within catchments in the region, specifically work undertaken for the Moreton Bay Waterways and Catchment Partnership by CRC industry affiliate WBM Oceanics. The project will also utilise linkages between EMSS and MUSIC (to be developed by new CRC research) to allow analysis at a range of catchment scales.

– Toolkit application
While the project is still undergoing final planning, the focus areas for applying the toolkit will be in the northern catchments of the SEQ region and the western and lower sub-catchments of the Brisbane River. The northern catchments are in an area that is undergoing rapid development. In addition, there are a number of active community groups in this area who are keen to develop a true partnership with government agencies examining natural resource management issues. A key need by both government agencies and the community groups is to understand and identify the major causes of catchment degradation at various time and space scales. Within the northern catchments, NRM are proposing to use EMSS as the vehicle to inform key catchment management stakeholders and, by developing some modeling capacity within the community groups, as a way of developing a "citizen science" approach to natural resource management.

– Western catchments
The western catchments of the Brisbane River are a focus area for the National Action Plan for Salinity and Water Quality and have been identified as one of the major contributing areas for sediment delivery into Moreton Bay. Some of the streams in the western catchments discharge directly into the mid-Brisbane River, which is a conduit of raw water supply from the large storage of Wivenhoe Dam, to the potable water treatments plants at Mt Crosby. Given the sensitivity of uses of the Brisbane River in this area, understanding the key pollutant sources and quantification of the efficacy of potential management actions is essential. Having predictive tools such as EMSS and MUSIC will provide consistent information regarding these issues to the various groups and agencies involved in catchment management in the region.

– Low catchments
Similarly, in the lower catchments, there is a need to understand the relative contributions of the various land-uses compared to that received from upstream. Brisbane City Council is currently developing a Water Management Strategy that considers the way in which all water resources will be used within the City and the region and the management actions that can be taken to preserve and/or enhance those resources. As part of the development of that Strategy, it has been decided to use EMSS to identify the catchment loads received by the lower Brisbane River from land-uses directly discharging to the lower Brisbane tributaries. These loads will be related to those being received from the upper and mid-Brisbane catchments in an effort to quantify the effects of proposed management actions in the Brisbane City region. This will assist Council in targeting management actions in areas where they are likely to have the most benefit.

Delivering the CRC Mission

From the research that has been undertaken within the Brisbane Focus Catchment, and the proposed CRC Development Project in the region, the CRC's mission of delivering predictive capability to resource/catchment managers to assess land-use and water management decisions will be realised.

This research has largely been possible due to the high degree of cooperation between researchers, Industry Parties and the relevant stakeholders within the Focus Catchment.

Acknowledgements
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THE FITZROY FOCUS CATCHMENT

by CHRIS CARROLL

The Fitzroy Catchment

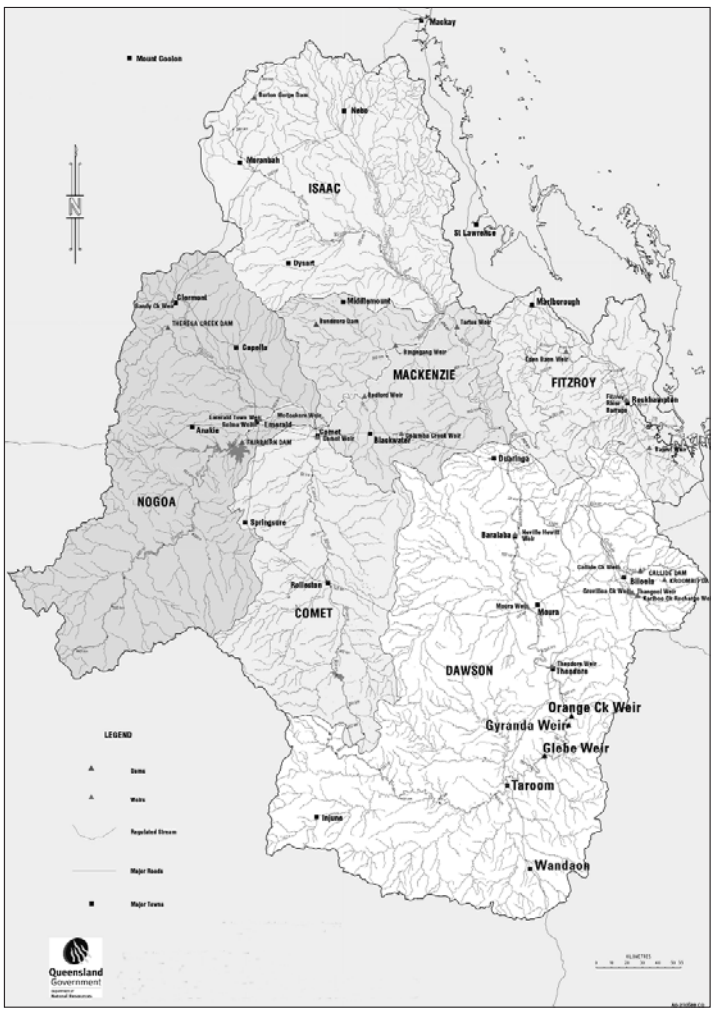
Covering an area of 142,000 km^2, the Fitzroy is the second largest coastal catchment in Australia. It is dominated by agriculture (grazing, dryland cropping, irrigated cotton and horticulture) and by mining (coal production of 100 million tonnes/year, magnesite, nickel and historically gold and silver).

The river flow in the Fitzroy is highly episodic with a seasonal bias to higher flows in summer. Annual sediment delivery from the catchment to the estuary has been estimated to be four million tonnes, and is associated with high levels of nutrients and some pesticides. The catchment has recognised land degradation problems including all forms of soil erosion by water, and soil fertility decline.

Land degradation and its impacts on sediment and water quality in the Great Barrier Reef (GBR) marine lagoon are receiving national attention through the National Action Plan for Salinity and Water Quality (NAPSWQ), and the GBR Marine Protection Plan.

The Department of Natural Resources and Mines in Queensland (NRM) is the primary natural resource manager with the role of managing land, water, soil, and vegetation resources in Queensland. However, the responsibility for establishing natural resource management targets in the National Action Plan for Salinity and Water Quality (NAPSWQ) falls to Regional Strategy Groups such as the Fitzroy Basin Association (FBA).

The ability to model catchment processes at a very large basin scale is a major challenge for the CRC, and the main reason that the Fitzroy was chosen as a focus catchment. The CRC has aimed to develop generic approaches for use in large-scale models that represent the effects of small-scale variability (in space and time) of soil and landscape characteristics, and precipitation, on various hydrological and water quality responses. The Fitzroy Development Project, discussed later in this article, will test the capacity of CRC models to model large basin scale processes and responses.



Fitzroy Catchment

CRC research meeting catchment needs

The Fitzroy is a 'focus' catchment for both the CRC for Catchment Hydrology and the CRC for Coastal Zone, Estuarine Waterway Management. The Fitzroy Basin Association and both CRC's have recognised the opportunity to link modelling activities to better understand the relationships between catchment activities on coastal regions.

The two CRCs and the FBA have been working together since mid-2000 to identify ways to further integrate research, and research outcomes, with local catchment activities. Part of this work involved

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.

developing a modelling framework that allowed the community stakeholders to evaluate the impact of future management and planning activities.

To facilitate this process the two CRCs ran a series of workshops where an Adaptive Environmental Assessment and Management (AEAM) approach was used to capture modelling, scientific and stakeholder knowledge on the Fitzroy and Keppel Bay region.

A three-day workshop, held over 10-13 September, 2001 in Brisbane was used to develop a framework of key water balance, flow and sediment processes in the catchment and the estuary, including social and economic aspects. The workshops followed earlier management and research stakeholder workshops in April 2000 and August 2001, and concluded with a workshop in Rockhampton in April 2002 that ran a series of management scenarios with the stakeholder group.

The AEAM workshops successfully brought together researchers and stakeholders with specific understanding of the Fitzroy catchment system. The workshops encouraged the group to combine their collective understanding of the physical, biological and economic behaviour of the catchment from land surface to estuary.

AEAM workshop participants working together to better understand the Fitzroy catchment.

The Fitzroy Development Project – building on partnerships

There is an opportunity to further build on the partnership established between the two CRC's and the FBA through the AEAM workshops by utilising the CRC models such as Environmental Management Support System (EMSS) and SedNet as tools to help set NAPSWQ management targets within the Fitzroy basin.

EMSS and SedNet are two modelling systems that have the potential to help set management and regional water quality targets under the NAP and similar natural resource management programs.

SedNet was developed as part of the National Land and Water Resources Audit for nation-wide assessment of mean annual sediment budgets. It has been applied successfully at that scale, but also in more focussed regional applications, notably in the Murrumbidgee and Moreton Bay catchments.

EMSS was developed specifically for water quality assessment in the South East Queensland Region for the South East Queensland Regional Water Quality Management Strategy.

The Fitzroy development project aims to apply these models in the Fitzroy focus catchment and will commence in January 2003. The CRC and Department of Natural Resources and Mines will continue to build on the partnership with the Fitzroy Basin Association to define and develop scenarios and model outputs relevant to the catchment needs. The South East Queensland EMSS model outputs will be used to demonstrate what can be achieved with the models. The adaptive approach and linkages with the CRC for Coastal Zone to better understand and model the catchment and coastal relationships will continue.

Specifically, the objectives of the Fitzroy Development Project are to:

- Provide the capability to model the impacts of land-use and management activities on sediment and nutrient transport at a range of catchment scales.
- Link the component understanding, research activities, monitoring and local activities to consider management actions that can be used to set management and regional targets for the NAPSWQ.
- Provide the modelling capability to NRM and ownership in modelling outcomes in partnership with the Fitzroy Basin Association stakeholders.

Specific outcomes expected over the next 12 months are:

- EMSS model for Fitzroy basin scale developed and running
- Model sediment generation and nutrient runoff from hillslopes, gullies and streambanks
- Evaluation of different land management scenarios at sub-basin and basin scale.
- An ability to predict impacts of land-use and management at a local catchment scale.

LEMSS and Neighbourhood Catchments

Target setting within the NAPSWQ requires management targets at various catchment scales. The Local Scale EMSS (LEMSS) is a modelling tool that provides a methodology that can consider land management scenarios at such a local scale.

NRM has two 'focus' Neighbourhood Catchments (300 km^2) that have detailed digital elevation models (scale 1:100,000) of land-use and management, flow and sediment and water quality data that can be used to calibrate and validate LEMSS. The Grains Research Development Corporation (GRDC) and Meat and Livestock Australia (MLA) fund the two neighbourhood catchment programs. Modelling of the catchments with the United States Department of Agriculture SWAT model has already been conducted and data layers already exist that can be used with LEMSS.

The Fitzroy Basin Association has identified community Neighbourhood Catchments as a major priority project for NAPSWQ in the basin. They see this as an approach where management and water quality targets can be set in partnership with local landholders and the community. Modelling outputs from both the basin and Neighbourhood Catchment scale using EMSS/SedNet and the LEMSS will be reported back to these community groups via the FBA and NRM jointly facilitated workshops.

The core project team consists of NRM researchers and GIS staff who will collate existing spatial data layers for the Fitzroy basin, Dawson sub-catchment and focus Neighbourhood Catchments, and supply hydrological and water quality data. An FBA technical officer will be on the project team to facilitate and identify management scenarios, and ensure linkages with the stakeholders in the Fitzroy basin.

The FBA recognises that there is a need for greater coordination and integration of research, development, extension and adoption activities in the Fitzroy. The Fitzroy Integrated Research Extension, Development and Adoption (FIRDEA) initiative has been established in the basin as a mechanism for integrating research, development, extension and adoption activities covering social, economic and environmental elements associated with sustainable natural resource management. Claire Rodgers is the Program Manager of FIRDEA and will chair a development project steering committee consisting of representatives from Natural Resources and Mines, Environmental Protection Agency, the Department of Primary Industries and Central Queensland University.

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Central highlands of the Fitzroy Catchment looking north-west towards the township of Emerald - a major cotton growing region.

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OUR MISSION

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

OUR RESEARCH

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

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

CRC AUSTRALIA

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

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