NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 101 DECEMBER 2001

A NOTE FROM THE DIRECTOR

Professor
Russell Mein

Inside...

COOPERATIVE RESEARCH CENTRE FOR
CATCHMENT HYDROLOGY

ANOTHER GOOD YEAR FOR THE CRC

With the December *Catchword* and a break ahead of us, it seems appropriate to reflect on the highlights of the year just completed, and to foreshadow what lies ahead for the Centre.

Some highlights of 2001
2001 was a pretty good year for the CRC. Particularly satisfying for all involved in the Centre is the high level of regard for their work by external reviewers.

Second Year Review
Our Second Year Review Panel (Stage 2) found us a 'model' CRC, meeting 'all the criteria of the CRC program to a high degree' and 'with no significant weaknesses'.

The Second Year Review is conducted in two stages, with Stage 1 concentrating on the quality of the research, and Stage 2 on all aspects of the Centre, including the Stage 1 findings. On the latter, the Stage 2 Panel noted 'The Stage 1 review, which was unusually thorough, concluded that the research plan is being executed as it was planned, and good progress is being made on all programs. This Panel agrees with this assessment and notes that the quality of the research and researchers is very high'.

My congratulations and thanks to my colleagues in the CRC for the quality of their activities in the CRC.

Communications Review
Effective communication is vital to any organisations and crucial for a Centre like ours, with research nodes and our end-users in widely spread locations. With achievement in the area a particular target for the CRC, early this year we conducted the first of three planned reviews of our communications activities; the aim is to quantify (and improve) our effectiveness throughout the life of the CRC. The independent review consultants noted that 'compared to other similar organisations, the CRC for Catchment Hydrology is a leader in its approach to planning, implementing and evaluating communication'. There were also very favourable comments on the effectiveness of these aspects so far.

We are pleased that our emphasis on communication and adoption in the CRC (reflected also in a commitment of some 20-25% of total resources) is so highly regarded by our stakeholders.

Education and Training
The postgraduate program is an important and successful one. Remarkable to me was the answer to a question put to the 14 postgraduates who attended a session at the Second Year Review - 'How many of you have had industry experience prior to commencing postgraduate studies'. With this group, 13 of the 14 students had worked in the water industry before coming to the CRC! Backgrounds such as this have helped us produce some wonderful students, like Rebecca Bartley (CRC Young Water Scientist of the Year, and winner of the postgraduate presentation award at the CRC Association Conference).

It is also part of the reason for the comment made to me by the Chair of a CSIRO appointment panel 'we have found this (lack of a big picture view) the biggest weakness in most applicants to jobs at CSIRO, but CRC for Catchment Hydrology students are always the exception; the CRC can be proud of its student development and industry training'.

Modelling Workshop
The mission for the CRC is an ambitious one, aiming for predictive capability of the effects of land and water management decisions at whole-of-catchment scale. Central to this is our modelling toolkit, a grouping of connected software packages for simulating a variety of management scenarios. Readers of *Catchword* will have seen the progress made by the toolkit team in selecting modelling frameworks. The next step (and this was also recommended by our Stage 1 Review Panel) was for the wider CRC to define the conceptual framework for the toolkit.

Some 24 people (toolkit team, Program Leaders, some Project Leaders, and some user agency staff) attended a two day workshop at Lancefield in November, and achieved the objective. We have developed a shared view as to what the toolkit will look like, and how our respective projects will contribute to it. [A follow-up workshop is planned for early next year to build on this one].

Next Year
Planning for the next round of core projects (to commence in 2003) will be an important activity next year. Our aim is to have this planning completed, with Board sign-off, by August 2002.

The coming year is also the last year of the current projects and thus the time of most research outputs. A focus for us will be maximising the benefits of these for our user Parties.

It is going to be another busy year.

On behalf of the CRC, my best wishes for the Season to all *Catchword* readers, and a productive and satisfying New Year.

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CRC PUBLICATIONS LIST

Copies of the Publications List are available on request from the Centre Office on 03 9905 2704 or can be downloaded from the CRC website at

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PROGRAM 1

PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

Report by Rob Argent

Modelling toolkit developments

Progress on selecting modelling frameworks

Project 1.1 has progressed well over the past few months. This month I will discuss some of the changes that have taken place, and the implications for the project researchers, potential toolkit end-users, beneficiaries of, and investors in, this research.

We have decided on moving forwards with two modelling frameworks – the "Builder" version of the Integrated Catchment Management System ("ICMSBuilder"), and Tarsier, the system used for development of the South-East Queensland water quality management application, EMSS. We have chosen two, rather than one, because neither provides all the functions that are required for an acceptable modelling toolkit for the CRC for Catchment Hydrology. The research work of Project 1.1 over the coming year involves investigating these functional deficiencies – most of which are embedded in the realms of software architecture, design and implementation – and selecting appropriate further steps forward. Development work within Project 1.1 during 2002 will involve close affiliation with our core link projects (Projects 2.3, 3.1, 4.1 and 5.2), and some work with other projects that have highly developed and tested modules ready for inclusion in the toolkit.

How do the two Frameworks fit in with the toolkit?

Figure 1.1 shows our current conceptualisation of the toolkit and the two frameworks. What does this figure mean? At the heart of the toolkit lie a suite of modules that, for example, undertake common hydrological calculations, or perform analyses or visualisation functions. Many of these modules already exist within Tarsier and ICMSBuilder, and we are working to produce more. A few of the modules exist in both frameworks, albeit in similarly designed but differently coded forms.

Stand alone Toolkit modules

Outside of the frameworks, but within the toolkit, are other modules that generally operate in a stand-alone manner. These are the sorts of modules that may provide very distinct functions, with a low requirement for linking to other modules. Examples of these may be some of the Hydrological Recipes. As the modelling toolkit and the frameworks develop over the coming years, and as CRC developers start developing their modules within the frameworks, the integration of these types of modules into the toolkit will change.

Existing application modules outside toolkit

Outside of the toolkit lie existing application modules that, for a number of reasons, we do not or cannot include. These reasons include:

- external stand-alone applications that do a particular job very well, and so there is no reason to duplicate their function in the toolkit;
- software that has not been designed using software engineering methods that are compatible with the toolkit;
- applications that are unavailable for inclusion due to commercial or other reasons, and
- immature research tools, where the design has not been finalised.

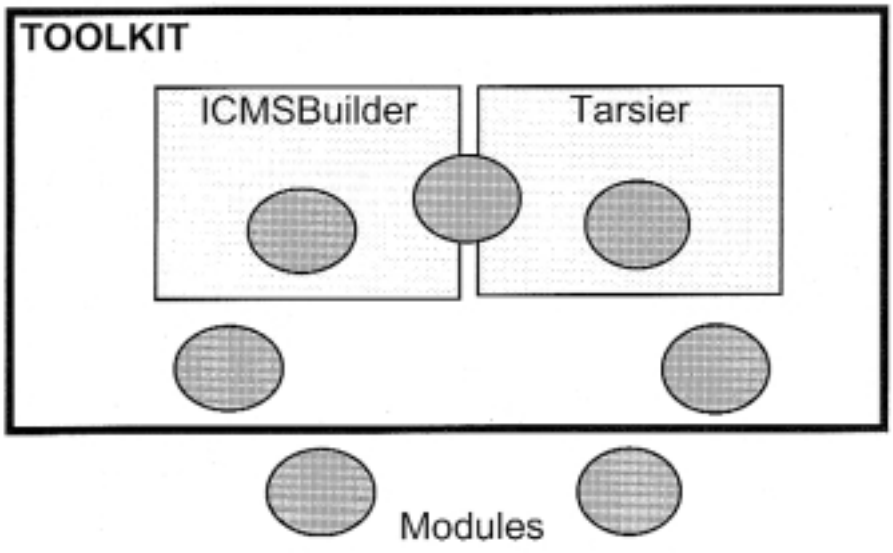

Figure 1.1 Toolkit conceptualisation including two frameworks and modules

Capacity to work with modules external to the frameworks and external to the toolkit can be provided by data exchange methods that translate output from one module to input for another. Part of the current work of Project 1.1 is aimed at sorting through some of the issues related to data exchange between application modules, with the aim of increasing consistency of data representation and exchange.

Where lie the difficulties, and what are the implications?
There are a few difficulties inherent in the approach given above, and much of the research undertaken with Project 1.1 is aimed at reducing these. The foremost difficulty appears to lie with the inability of the two frameworks to share modules. In fact, for many researchers, this problem is secondary to that of the learning that will be required to create programs in a modular way. We believe that, for well designed modules, porting from one framework to another will be relatively easy, although we have yet to test this for a comprehensive range of modules.

Each of the frameworks has various positives and negatives, in a range of areas that includes training support, conceptual requirements, programming, framework operation, and application performance. For our key link projects, we will be providing support and undertaking some module coding within Project 1.1, and will select a framework appropriately. For researchers and end-users wishing to create modules, the choice of framework should be based upon experience gained during training. In the end, selection of a framework for an individual should be based upon individual preference and an alignment of developer needs with framework function.

We will be providing a series of training activities for the two frameworks over the coming year, so there will be plenty of opportunity to work out which framework meets your needs.

Summary
Overall, this year has seen great progress within the toolkit project, with considerable development, testing and delivery in both the conceptual and engineering realms. For 2002 we will continue to research and develop the pilot toolkit, with inclusion of a range of modules now coming on line from other CRC for Catchment Hydrology projects.

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PROGRAM 2
LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

Report by Neil McKenzie, John Gallant and Linda Gregory

Estimating water storage in soils and regolith (or mantle rock) at catchment scales

Current knowledge of water storage
Most of the rain that falls on our catchments is stored in the soils and regolith (the layer of loose rock resting on bedrock) before being transpired by plants, entering the groundwater system or becoming streamflow. Our understanding of this storage, and the influence it exerts on processes, is constrained by our ability to describe the spatial extent of the storage in a catchment. Maps of soil and regolith depth simply don't exist. This article describes a new approach to this problem by the team at CSIRO Land & Water in Canberra.

Project requirements
Information on catchment water storage in soils and regolith estimates is needed to input to catchment models for estimating the impact of vegetation change on stream flow. The information has to be provided in the first instance at the scale of the small catchment so that it can be matched with gauging stations and stream flow records. However, data will be eventually required for small to medium sized catchments.

Estimation methods
Current methods for estimating plant available water and total water storage that rely on land resource data have a range of limitations. A scheme for providing more realistic estimates of water storage has been developed. It uses new methods of terrain analysis in conjunction with conventional sources of soil information to provide better spatial prediction of soil depth.

Terrain variables are used to scale soil depth estimates taken from published land resource surveys. In areas where erosional processes dominate, the topographic wetness index is used to predict soil depth. In depositional areas, a new terrain index, developed by John Gallant and Trevor Dowling, is used. The so-called 'multi-resolution valley bottom flatness index' appears to be very useful for characterising depositional areas. A fuzzy weighting is applied to predict soil depth in the intermediate zones. An example of our results for Kyeamba Creek Catchment in NSW is presented in *Figure 2.1*. Water retention pedotransfer functions or direct measures are used in conjunction with the depth estimates to estimate maximum water storage of the soil and regolith.

NEW TECHNICAL REPORT

IMPLEMENTATION OF A MEAN ANNUAL WATER BALANCE MODEL WITHIN A GIS FRAMEWORK AND APPLICATION TO THE MURRAY-DARLING BASIN

by
Andrew Bradford
Lu Zhang and
Peter Hairsine

Report 01/8

The report describes the implementation of a simple water balance model in a GIS (Geographic Information System) framework for assessing average annual streamflows (water yield) under different land-use scenarios in the Murray-Darling Basin. The model requires only catchment percentage forest cover and mean annual rainfall. The report describes the water balance model, its input data and the process required to prepare those data.

Copies available through the Centre Office for $27.50.

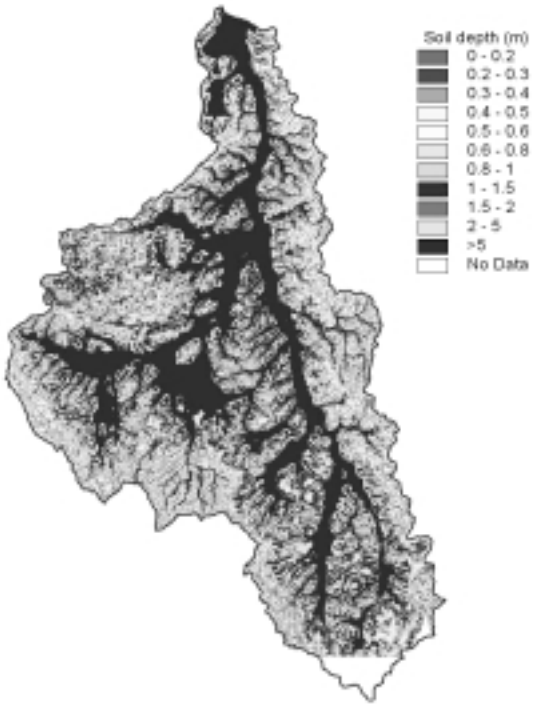

Fig. 2.1 Soil depth estimates, Kyeamba Creek catchment, NSW

Other data sources

The relative gains in predictive success associated with higher resolution sets of source data for soils and digital elevation are being examined. The predictive capability of the Digital Atlas of Australian Soils used in conjunction with the continental nine second digital elevation model (DEM) is being compared with a higher resolution DEM (25 m grid cells) and 1:100 000 scale soil survey data.

The scheme provides more realistic estimates of catchment water storage than previously available from land resource survey data. The innovative method of terrain analysis appears to be robust and initial results are promising. However, several problems with soil water retention data have to be resolved. The results will be presented in a CRC for Catchment Hydrology publication in the near future.

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Report by David Rassam

Hydrology of riparian buffer zones

Nitrogen removal by buffer zones

Nitrate contaminated groundwater may eventually reach river systems and pose potentially serious environmental problems such as algal blooms. Riparian zones can provide a protective buffer between streams and adjacent land-based activities by removing nitrogen from shallow groundwater flowing through them.

Project 2.5 investigates the role of riparian zones in controlling nitrate delivery to streams and a report in the August 2001 issue of *Catchword* provided an overview of project developments. Briefly, a pilot experimental site is located in the Coochin Creek catchment, which drains to the Pumicestone Passage in Moreton Bay. The site has healthy riparian vegetation along the creek, sandy sediments, and a shallow groundwater table. Preliminary measurements have shown a relatively high organic carbon content in riparian soils (up to 5%). Organic carbon is a vital component for the denitrification process, an important mechanism for removing nitrogen from the riparian zone.

Subsurface hydrology

A sound understanding of subsurface hydrology is essential for assessing how riparian buffer zones function. Factors such as surface topography, climatic conditions, soil type, soil layering and preferential flow paths, collectively control the hydrology and hence drive event-based, and seasonal water table fluctuations.

Experimental site

A comprehensive study of the hydrology of the experimental site is currently underway. The main area of interest in the site is about 25 m wide and 50 m long (direction parallel to stream, see *Figure 2.2*). Upon conclusion, the study should provide the following:

- an insight to the hydrology of the site,
- valuable input data for future modelling work, and
- a clear direction for the water quality monitoring program, and detailed process studies of denitrification.

Site topography

Figure 2.2 shows a detailed survey map of the experimental site (the coordinates refer to Australian Map Grid). The 0.5-m contour lines show that the pineapple plantation is about 2m higher than the creek level. The major hydrologic features at the site are the creek and the pond. The latter is a depression that acts as a storage tank, which fills up with water and eventually overflows, thus triggering flow in the stream. Preliminary results from the logged pressure transducers have shown that the pond plays a crucial role in the hydrology of the site.

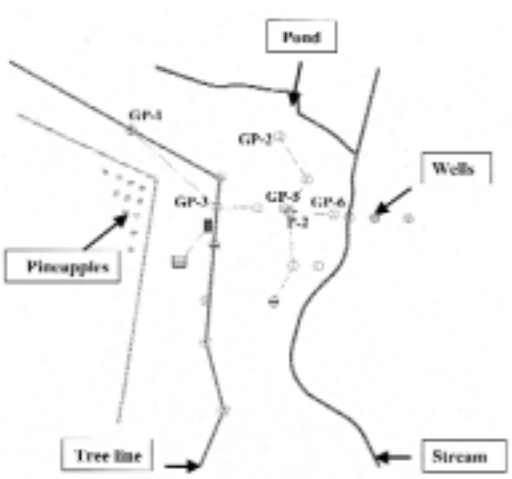

Figure 2.2 a map of the experimental site

Soil investigations

Soil description of the disturbed cores obtained from five locations in the site revealed the presence of a sandy aquifer at depths ranging from 2-4m (10-11m, Australian Height Datum (AHD). The top layers vary from medium clay, sandy clay, to sandy loam. It is too early to judge whether those layers are connected (and hence result in a perched water table) or merely disconnected lenses.

Undisturbed soil cores taken from the site will be used for leaching column experiments in the laboratory to provide estimates of the soil hydraulic conductivity and solute transport parameters. The latter is a valuable input for the field tracer experiments, which will be conducted at a later stage.

Pumping tests

Pumping tests were carried out to estimate hydraulic parameters such as the hydraulic conductivity and specific yield of the soil, with pressure transducers continuously logging both the pumping-out and recharge stages. Preliminary results of the tests have clearly demonstrated a highly variable response, reflecting the variability of the hydraulic parameters of the various soil horizons.

Preliminary insight into hydrology

Prior to a recent rainfall event that followed a long dry period, the stream was not flowing and the water level in the pond was at a minimum level of about 10 m AHD. Shortly after the rainfall event, the pond filled up to a level of about 11.5 m AHD and streamflow was triggered. The following comments can be made regarding the response of the four wells shown in *Figure 2.3.*

- GP2 is closest to the pond and is the first to respond.
- The delayed, sudden response of GP6 (the closest to the stream) indicates that water is flowing in the stream.
- The most interesting response is that of GP5. Up to time=20 hrs, GP5 exhibits a response similar to that of GP2 and GP1. During that time (i.e. no streamflow), the water level in GP5 is driven by the gradient between it and the pond. Following flow in the stream, the water level in GP5 starts to rise dramatically; note how it changes slope beyond 20 hrs, after GP6 has approached the quasi steady state.
- At the end of the dry season, GP1 had the highest water level, but following the rainfall event its water level became the lowest. This suggests that the dynamics of the system are seasonal, and/or event driven.

Future work

- Analysis of the pumping data to estimate the hydraulic parameters of the different soil horizons.
- 3-D Modelling of the hydrology of the site using MODFLOW to present a complete picture of the flow paths.
- Coupling the transient pressure transducer data with inverse modelling techniques to develop a refined version of soil parameters.

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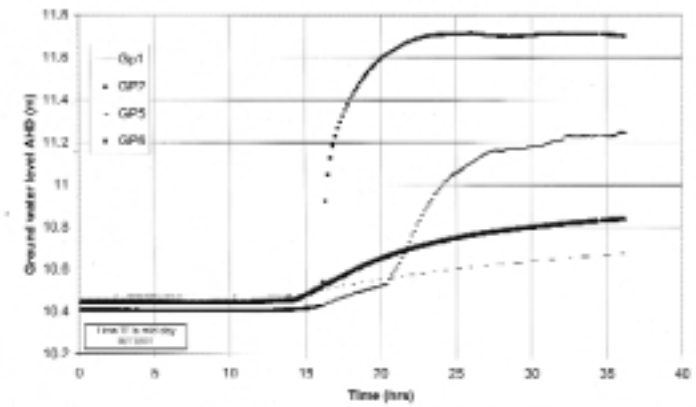

Figure 2.3 Response of four wells to a streamflow event

UPDATED EVAPOTRANSPIRATION AND RAINFALL MAPS FOR AUSTRALIA

Where to get them!

The CRC for Catchment Hydrology and the Bureau of Meteorology have recently completed a project to produce national maps of evapotranspiration for Australia.

The map set is now available for $33 plus postage and packaging.

They can be purchased from:

1. Publications Section,
9th floor, 150 Lonsdale St Melbourne.
tel: 03 9669 4000
(main switch) and ask for Publications

OR

2. Bureau Regional Offices (all capital cities)
Contact details for each Regional Office are available at
http://www.bom.gov.au/inside/contacts.shtml

Information about the climate atlas map sets and the digital map data sets can also be obtained from: National Climate Centre Ph: 03 9669 4072
Email: webclim@bom.gov.au

Technical queries about the evapotranspiration modelling can be referred to
Dr Francis Chiew at The University of Melbourne
email
f.chiew@civag.unimelb.edu.au

Any technical queries about the mapping should be referred to
Graham de Hoedt
tel 03 9669 4714
email: g.dehoedt@bom.gov.au

NEW TECHNICAL REPORT

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

by

John Tisdell
John Ward
Tony Grudzinski

Report 01/1

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

Copies available through the Centre Office for $27.50.

PROGRAM 3
SUSTAINABLE WATER ALLOCATION

Program Leader
JOHN TISDELL

Report by John Tisdell

Project 3.2: Enhancement of the water market reform process

Water market experiments

In the next phase of Project 3.2 we will be conducting laboratory-based experiments of alternative trading rules and procedures. So far we have:

- developed the necessary software, coined MWATER,
- conducted trials with students at Griffith University, and
- presented the initial findings and proposed methodology at an experimental economics conference in Arizona (where the work was well received.)

The next step is to hold meetings with each of the industry Parties to demonstrate the methodology and discuss research strategies for the next phase.

Evaluating water trading rules and procedures

Over the next twelve months experiments will be held to evaluate alternative water trading rules and procedures with students and farmers under controlled conditions in the focus catchments – much like trialing a new variety of wheat before release.

The advantages of laboratory water markets are great, both as an educational tool and as an instrument for policy evaluation. Irrigators can gain an understanding of how water markets operate prior to trading water in naturally occurring markets. The water authority can test alternatives in a matter of days, prior to release over many years. Like all laboratory experiments the results give a guide to what may happen once the policy option is released.

Experimental auctions

The experiments are computer assisted using a package coined MWATER, written by John Tisdell and Tony Grudzinski. MWATER is written in visual basic and can be used in experiments involving call auctions, and 1st price, 2nd price, Dutch and English auctions between 12 farm types.

In closed call auctions, similar to those held in the Goulburn-Broken catchment, the package uses 25 VBA macros to generate:

- monthly rainfall information for each farm
- a record, and a process to buy and sell bids
- supply and demand schedules and equilibrium prices and quantities and
- monthly farm income and water accounts for each farm

The package has been developed for use with farmers in locations where computer laboratories or web access in not commonly available. In time, a web-based version will be developed and linkages with packages within the CRC for Catchment Hydrology toolkit will be explored.

Participation by farmers

Over the next few months field experiments will be held in focus catchments with farmers – the first being planned in the Murrumbidgee catchment. In time, experiments will be developed not only to explore farmer-farmer and farmer-water authority trading, but also intersectoral and interstate trade.

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PROGRAM 4
URBAN STORMWATER QUALITY

Program Leader
TONY WONG

Report by Margaret Greenway

Biofilms – form and function, and their role in urban stormwater treatment

Form

Biofilms are living communities of a variety of micro organisms – bacteria, algae, fungi, protozoans – embedded in a slimy, glue-like organic matrix, adhering to a surface. The major constituent of the matrix is water, the remainder is protein and sugar-like substances referred to as extracellular polymeric substances (EPS).

Although the term "biofilm" is relatively recent, freshwater and marine biologists have studied the structural form and taxonomy of such communities growing on the surfaces of rocks and plants since the early 1900s (these communities have been referred to as "aufwuchs" "periphyton" and "epiphytes"). Although periphyton and epiphytes are predominantly unicellular or filamentous algae, whole communities of other organisms co-exist. Ecologists have been aware of the functional role of periphyton since the 1950s. Howard Odum published his classic work on primary production of freshwater eelgrass and attached periphyton of Silver Springs, (Florida) in 1957.

Environmental conditions and gradients

Populations of micro-organisms vary in community structure depending on environmental conditions and gradients. Biofilms attached to the surface of stones in a stream, or stems of aquatic plants, are dominated by unicellular algae and cyanobacteria, since there is plenty of light for photosynthesis. In deeper, light-limited environments, bacterial and fungal populations dominate. Biofilm communities also vary in response to oxygen gradients, with anaerobic micro-organisms replacing aerobic micro-organisms as oxygen availability decreases. Environmental gradients also occur at the micro-scale within the biofilms themselves. Epiphytic algae growing on stems of aquatic plants cause shading, thus photosynthetic micro-organisms grow on top of non-photosynthetic organisms (*Figure 4.1*). This in turn, may also promote an oxygen gradient with the biofilm.

Many interactions, such as co-metabolism, occur as a result of these gradients. The positioning of different nutritional types and physiological types of micro-organisms across aerobic or anaerobic environments means that the products of one form of metabolism are exchanged across the interface, providing essential requirements for the growth of a different type of micro-organism. For example, in sediments, aerobic conditions may facilitate nitrifying bacteria which convert ammonium or nitrate to nitrate, whereas under anaerobic conditions denitrifying bacteria convert nitrate to nitrogen gas.

Biofilm development

Biofilm formation involves:

- the transport of inorganic and organic molecules, particulate matter and micro organisms to the surface to be colonised;
- the adsorption and accumulation of these molecules and particles at the solid - liquid interface;
- the adhesion of micro organisms;
- cell multiplication and further colonisation

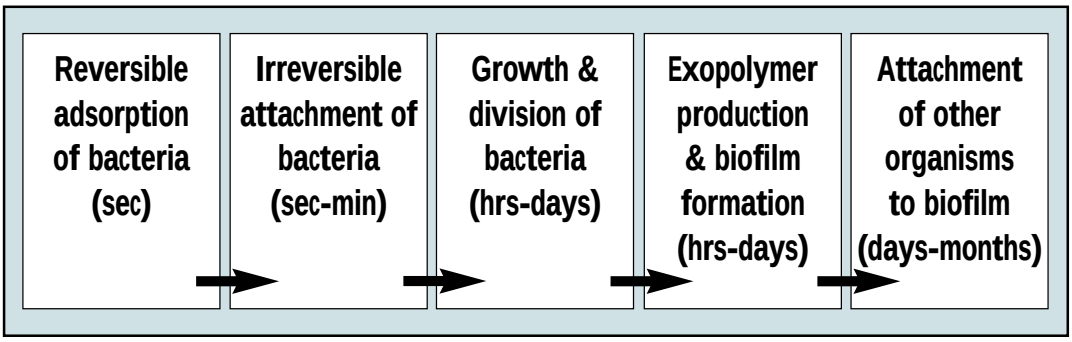

Figure 4.1.Biofilm formation (Source: ASM Biofilms Collection)

NEW WATER ALLOCATION RESEARCH REPORT

IRRIGATOR AND COMMUNITY ATTITUDES TO WATER ALLOCATION AND TRADING: A COMPARATIVE STUDY OF THE GOULBURN BROKEN AND FITZROY CATCHMENTS

by
John Tisdell
John Ward
Tony Grudzinski

Report 01/5

This new technical report details the findings of a comparative study of attitudes and opinions on water reform, allocation and trading between irrigators and community members in the Goulburn Broken (Vic) and Fitzroy (Qld) catchments.

The analysis provides insights to general opinion, and expectation of and blockages to, water reform in two eastern Australia catchments.

All of our publications can be ordered through the Centre Office.

NEW TECHNICAL REPORT

WATER SENSITIVE URBAN DESIGN IN THE AUSTRALIAN CONTEXT - CONFERENCE SYNTHESIS

by
Sara Lloyd

Report 01/7

In August 2000 a conference was held in Melbourne to highlight and explore the opportunities and impediments to the adoption of Water Sensitive Urban Design (WSUD). WSUD is the term used to describe a new approach to urban planning and design that offers sustainable solutions for the integration of land development and the natural water cycle.

This report collates and summarises the key issues raised at the conference, focusing on the current barriers to the widespread adoption of WSUD principles and offers possible solutions to help overcome both short term and long term issues.

Please note that conference attendees will be sent a complimentary copy

Copies available through the Centre Office for $27.50.

For further information contact the Centre Office on 03 9905 2704

The EPS is produced by micro-organisms within the developing matrix following colonisation. The entrapment of water reduces the impact of dehydration due to periodic drying-out and serves as protection to minimise physical, chemical and biological impacts. The outer layer of biofilm can physically protect the inner microbial cells, or the host surface, from UV, heat, and harmful chemicals, and modify the impact of physico-chemical conditions e.g. pH, salinity.

Biofilm development ranges from a few hours to several months to reach equilibrium. The outer surface is continually changing as the cells slough off. The dynamic nature of biofilms means that a stable state may rarely be reached.

Nutrient diffusion through biofilms can be slow and therefore the availability of nutrients may be limited to micro-organisms in the inner layers. In the case of such nutrient gradients, cells closest to the surface receive sufficient nutrients from the surrounding environment for active reproduction, but as the width of the biofilm increases the inner cells may become inactive due to lack of nutrients. As biofilm width continues to increase, cells die in the inner deepest layer causing the whole biofilm to slough off from its attached substrate.

Function in wastewater treatment

Biofilms are highly effective in trapping both soluble inorganic and organic nutrients, as well as particulate matter. The wastewater industry has actively promoted the effective design of biofilter systems to remove nutrients, dissolved organic matter, and suspended particles.

Trickling filters used in secondary sewage treatment maximise the surface area for biofilm colonisation by providing a bed of crushed rock or moulded plastic. Air circulates through the rock maintaining aerobic conditions enabling the micro-organisms to oxidise much of the organic matter and ammonium. Thus biofilms are particularly effective in removing BOD and nitrogen.

Rotating biological contact systems promote biofilm growth on discs; the accumulated biofilms slough off when too thick – these flocs settle out and are removed. Significant nitrogen removal in aerobic bioreactors can be attributed to strong interaction of aerobic ammonium and nitrite oxiding bacteria in the upper layer and anoxic ammonium-oxidising micro-organisms in the deeper layers. The aerobic ammonium and nitrite oxiding bacteria in the upper biofilm layer produce nitrite and nitrate which diffuses into deeper anoxic layers where it is reduced anaerobically in parallel with anoxic ammonium-oxidising bacteria.

Role of biofilms in urban stormwater treatment

Nutrients are essential for microbial growth at the surface interface and for biofilm thickening. Thus stormwater provides the ideal "growth media" for biofilms. However, to facilitate biofilm formation, surfaces must be provided; the greater the surface area available, the higher the potential for the removal of nutrients and particulate matter.

- *Surfaces for biofilms*

Surfaces such as rocks, gravel and sand, and the submerged stems and leaves of aquatic plants are ideal for biofilm colonisation. Constructed wetlands promote biofilm growth on the surfaces of the vegetation, thus plants and biofilm communities contribute towards nutrient removal. The sticky matrix of the biofilms also facilitates the trapping of finer particulate matter which includes both inorganic and organic particles.

- *Leaves of submerged plants*

The early work of Odum and others in the 50's and 60's and more recent research in the 1990's have confirmed the high rate of primary productivity attributed to biofilms (periphyton) on the leaves of submerged aquatic plants, including the removal of bio-available nitrogen and phosphones. These photo-synthetic micro-organisms, like the plants upon which they grow, are dependent on light. The microbial composition will therefore change with differing light intensity.

- *Rocks, sediments*

Similarly the surfaces of rocks, gravel and sediments will be dominated by photo-synthetic organisms where sufficient light is available. Thus, shallow concrete channels or rocky stream beds characteristically develop a slimy green covering due to periphyton growth. The growth of periphyton mats has actively been promoted in Florida to remove nutrients from stormwater and agricultural run-off.

- *Treatment devices*

Other stormwater treatment devices such as sediment basins and infiltration systems also have the potential to support biofilms which can assist in water quality improvement. Substrates such as sand, gravel and rock provid the surface area for biofilms, the water provides the nutrients for growth. While a number of studies have looked at biofilms in constructed wetlands and their contribution to nutrient removal, little research has been conducted on the potential role of biofilms in these infiltration systems.

Current research

Research at Griffith University is examining the role of biofilms in stormwater infiltration systems. Key research questions being addressed include:

- What types of substrate and size of substrate are most suitable for biofilm colonisation?
- What functional groups of micro-organisms colonise and grow on these substrates?
- What is the capacity of these biofilms to remove suspended solids and nutrients?
- What are the effects of hydraulic loading?
- What are the effects of wetting and drying?
- What are the effects of heavy metals and hydrocarbons on biofilm growth?

It is anticipated that this research will provide us with information on the optimal environmental conditions for biofilm growth and function, and the suitability of substrate types for effective nutrient and suspended solid removal.

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IMPROVING URBAN STORMWATER QUALITY BY NON-STRUCTURAL MEANS

The Cooperative Research Centre for Catchment Hydrology has begun a project to evaluate the effectiveness of non-structural measures to improve urban stormwater quality. The project is primarily funded by the Victorian EPA.

Non-structural stormwater management measures include community awareness campaigns, planning controls, legislative controls, enforcement campaigns, etc.

The use of such measures is now widespread and can have many advantages, such as:

- Minimising pollution at the source.
- Minimising pollution that is often difficult or expensive to trap via structural measures (eg constructed facilities) in an urban environment (e.g. fine sediment, filterable reactive phosphate, groundwater contamination).
- Relatively low life cycle costs.
- The ability to quickly change strategy, if needed.
- The ability to involve the broader community in urban stormwater management (e.g. in education campaigns).

Despite these advantages however, there has been little work done to measure the effectiveness of these non-structural measures, and to assess the timeframe required to produce the desired outcomes. This lack of information is currently a major impediment to urban stormwater managers.

The CRC is currently seeking the assistance of stormwater managers who can provide information on attempts to measure the outcomes and life cycle costs associated with non-structural measures to improve urban stormwater quality.

If you can assist the CRC in this important project, please contact André Taylor andretaylor@iprimus.com.au or Tel or Fax: 08 9386 7565.

WATER SENSITIVE URBAN DESIGN

WATER SENSITIVE ROAD DESIGN - DESIGN OPTIONS FOR IMPROVING STORMWATER QUALITY OF ROAD RUNOFF

by

Tony Wong
Peter Breen
Sara Lloyd

Report 00/1

This joint publication with the CRC for Freshwater Ecology investigates opportunities for incorporating stormwater quality improvement measures into road design practices for protecting aquatic ecosystems.

Copies of the report are available from the Centre Office for $27.50 (includes postage and GST).

Please phone Virginia Verrelli on 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au

NEW WORKING DOCUMENT

MODELLING VICTORIAN ANNUAL RAINFALL DATA

by

Ratnasingham Srikanthan
Tom McMahon
Mark Thyer
George Kuczera

Working Document 01/1

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

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

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

Copies available through the Centre Office for $22.00

PROGRAM 5
CLIMATE VARIABILITY

Program Leader
TOM McMAHON

Report by Francis Chiew

El Nino/Southern Oscillation and Australian Rainfall and Streamflow

Analysis of ENSO-rainfall-streamflow teleconnection

The relationship between:

- El Nino-Southern Oscillation (ENSO) and
- Australian rainfall and streamflow, and the
- serial correlation in streamflow

can be exploited to forecast rainfall and streamflow months in advance. These forecasts are invaluable to the management of land and water resources, particularly in Australia where the streamflow variability is greater than elsewhere in the world.

Figure 5.1 summarises the lag relationship between rainfall and streamflow versus two explanatory variables from a recent analysis using data from about 300 catchments across Australia. The plots show the percentages of catchments analysed with significant correlations between seasonal rainfall or streamflow versus the Troup Southern Oscillation Index (SOI) (an indicator of ENSO) over the previous season. The plots also include the serial correlation between rainfall or streamflow versus rainfall or streamflow from the previous season. The percentages shown are for correlations that are statistically significant at $\alpha = 0.05$, $\alpha = 0.01$, and correlation coefficients above 0.5.

Similar analyses have been done before [1,2], but this is the most comprehensive - using almost 100 years of consistent streamflow and lumped catchment rainfall data. The catchments are unimpaired and have areas ranging between 50 and 2,000 km^2. The opportunistic data comes from a recently completed National Land and Water Resources Audit project on the extension of streamflow data[3].

Serial correlation in streamflow

The serial correlation in streamflow is generally by far the highest of all the correlations, particularly in south-west and south-east Australia. The serial correlation is highest in winter and spring, and is statistically significant in about half the catchments throughout the year. The high serial correlation in streamflow results from the delayed response in the rainfall-runoff process,

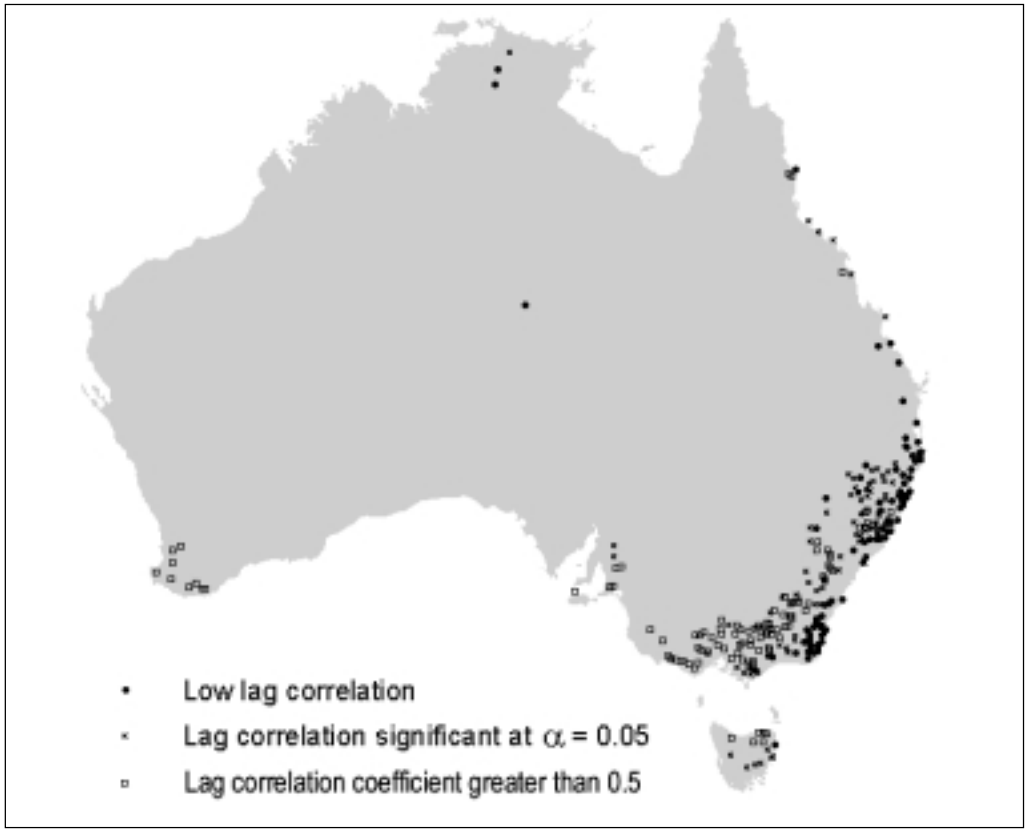

Figure 5.1. Summary of lag correlations between rainfall and runoff versus SOI and rainfall and runoff serial correlations from analyses of data from 300 catchments across Australia

due to soil and groundwater storage, giving streamflow a memory of conditions over several months. However, this "memory" in the streamflow data disappears relatively quickly. Over longer lags, ENSO indicators are likely to be better explanatory variables for forecasting streamflow.

Rainfall-SOI and streamflow-SOI lag correlation

The lag correlation between rainfall or streamflow versus SOI is highest in spring and summer with more than 60% of the catchments showing statistically significant correlations.The lag correlations between spring runoff and winter SOI for the 300 catchments are summarised in *Figure 5.2* (lag correlations between rainfall and SOI are similar).

The spring rainfall and streamflow show moderate to high correlation against winter SOI throughout eastern Australia, except New South Wales east of the Great Dividing Range.

The summer rainfall and streamflow also show moderate to high correlation against spring SOI throughout most of eastern Australia, including the coastal areas of New South Wales.The strength of the ENSO-rainfall and ENSO-streamflow teleconnections shift northwards from spring to summer, with the southern parts of east Australia showing lower lag rainfall/streamflow versus SOI correlations in summer compared to spring.

Seasonal rainfall and streamflow forecasting

The relationship between ENSO and rainfall and streamflow can be exploited to forecast spring and summer rainfall and streamflow several months in advance for most parts of eastern Australia and some parts of south-west Australia. In deriving the streamflow forecasts, the serial correlation in streamflow must also be considered because it is usually similar or stronger than the lag correlation between streamflow and ENSO. The serial correlation in streamflow is high for most parts of the year, and can also be exploited to forecast winter runoff, particularly in south-east and south-west Australia.

The Australian Bureau of Meteorology issues seasonal outlooks of rainfall every month based on the relationship between rainfall and ENSO. A research study in the CRC's Climate Variability Program on the development and testing of a non-parametric model for forecasting exceedance probabilities of rainfall and streamflow is nearing completion.

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[2]Chiew, F.H.S., McMahon, T.A., Zhou, S.L. and Piechota, T.C. (2000) Streamflow variability, seasonal forecasting and water resources systems. In: Applications of Seasonal Climate Forecasting in Agricultural and Natural Ecosystems – The Australian Experience (Editors: G.L. Hammer, N. Nicholls and C. Mitchell), Kluwer Aademic, pp. 409-428.

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CONFERENCE PROCEEDINGS

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

27-29 August 2001

Brisbane, Queensland

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

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

PROGRAM 6
RIVER RESTORATION

Program Leader
IAN RUTHERFURD

Report by Brett Anderson, Dom Blackham and Debbie Woods

Environmental Flows … the State of Play

Environmental flows are now becoming critical as a result of the COAG Water Reforms and other government initiatives, but how do we implement environmental flows? What is the science behind environmental flows? What are the tools for assessing the flow requirements of natural systems? What are the needs of managers and the community for information from flow assessments and flow provision? These questions and more were addressed in a highly successful seminar held on November 19 at the Melbourne Zoo. The objectives of the seminar were ambitious, but Mike Stewardson, Lance Lloyd and their team assembled a world class line-up of presenters ready and prepared to meet the environmental flows challenge.

This is a report on our day at the zoo, a day that may inspire a leap forward in the adoption of environmental flow practices in Australia. Over 200 delegates attended the seminar that was presented by the River Basin Management Society, the Institution of Engineers, Australia, the CRC for Catchment Hydrology and the Environmental Engineering Society – with the support of Melbourne Water, Thiess Environmental Services and Goulburn-Murray Water.

The Knowledge Base

The scientists on the presentation team lead us on a tour of the truly interdisciplinary world of rivers and their floodplains. Chris Gippel of Fluvial Systems Pty Ltd laid the foundation for the day – as is the geomorphologist's want – with a description of the changeable physical structure of our fluvial systems. Paul Humphries (CRC for Freshwater Ecology) and Jane Roberts (private consultant) then introduced some of the critters (i.e. aquatic fauna) and plants that populate riverine and riparian ecosystems, and which environmental flows are designed to sustain. Terry Hillman (Murray Darling Freshwater Research Centre) completed the overview with an examination of the importance of floods in maintaining a healthy connection between our rivers and floodplains.

Geomorphology

At the core of the environmental flow philosophy is the desire to allocate an amount of water to maintain a healthy river system. Contemporary thinking emphasises the need to define an environmental flow regime, incorporating flows of different magnitudes, durations and timing that to some extent mimic the natural intra- and inter-annual variability of the river system. The science of geomorphology is rich with ideas that link specific morphological features to particular discharges. Geomorphological tools provide a means for designing flow regimes that nurture a variety of habitat spaces required to maintain healthy fluvial ecosystems. Aquatic biota need the right flow patterns to sustain life-supporting processes, but without suitable habitat to complement these flows, biota cannot thrive in the stream. The maintenance of geomorphological channel-forming processes is critical for providing this habitat.

Aquatic Fauna

The prosperity of aquatic ecosystems is linked to flow variability in a similar fashion to morphological features. For instance the spawning behaviour of some fish species is known to be triggered by particular combinations of flow and temperature. Paul Humphries described some recent CRC for Freshwater Ecology research that suggests stocks of some fish species are critically dependent on low flow periods. The data showed that low flows are likely to be important for the successful recruitment of some species by providing conditions in which concentrations of prey are high enough to sustain fish larvae when they are at their most vulnerable. Paul concluded that irrigation flow regimes may prevent successful recruitment by changing the timing of low flow periods. Environmental flow regimes could therefore have a great impact on populations of aquatic fauna by incorporating appropriate flow variability, in this case low flow periods following known spawning times.

Aquatic and Riparian Plants

Jane Roberts identified substantial shortcomings in the literature pertaining to aquatic and riparian plants. The study of these plant communities, while building momentum, is still in its infancy, and could do with some strategic redirection. For instance, at present, studies tend to be biased towards species level investigations of 'pet' plants such as river red gums, and cover only a very limited range of field sites. With riparian zones supporting between 200 and 700 individual plant species, perhaps a better way to proceed is with studies based on groups with shared attributes and similar ecosystem functions. The challenge for botanists is to forge a link between riverine and riparian plant ecology and hydrology and geomorphology. Such work is essential to provide insight into the interdependency of vegetation and flow characteristics, a fundamental input to any rational process for the design of environmental flow regimes.

The Floodplain

The interaction between the floodplain and the river channel appear likely to be critical to the long-term health of river ecosystems. Terry Hillman described some current field-testing that attempted to identify the ecological significance of the periodic connection of rivers to adjacent billabongs. For instance overbank flows tend to 'top-up' billabongs and trigger a sequence of ecological responses culminating in a burst of zooplankton numbers within one to two weeks. It was thought that such a concentrated food source may be important in the recruitment stage of some native fish populations. However, the data suggest that macroinvertebrate communities in rivers and billabongs are largely independent of each other.This research clearly demonstrates that there is much yet to learn about the importance of flooding flows on river ecosystem health. Therefore, the best guide to designing environmental flow floods remains the characteristics of the natural flow series.

New methods for assessing environmental flows

Following the discussion on the current state of knowledge in environmental flow determination, the second session comprised three presentations of new methods for assessing environmental flow requirements, with accompanying case studies.

Michael Shirley of Sinclair Knight Merz (SKM) presented a new method for determining environmental water requirements, a method developed as part of a project undertaken on behalf of the Victorian Department of Natural Resources and Environment (DNRE). The requirement for Streamflow Plans to be implemented across Victoria was the driver behind the development of the new method, and Michael clearly illustrated the advantages that the new approach would provide. The integration of a range of technical disciplines and a strong structure for objective setting were the key advances stressed by Michael, who also promoted the benefits of recommending a target flow regime, rather than simply a minimum flow requirement.

Mike Stewardson, Project Leader in the CRC for Catchment Hydrology, presented a new approach for determining environmental flow requirements, entitled the Flow Events Method. Although similar in some regards to the work presented by Michael Shirley, the Flow Events Method focuses on the identification of specific hydraulic events (e. g. the exposure of stream bed, the inundation of benches, or the loss of slow water habitat for fish). The benefits of the Flow Events Method are its systematic and transparent structure and the facility for including ecological data and expert opinion in a structured and consistent way.

An alternative environmental flow philosophy for unregulated streams was presented by Rory Nathan of SKM, who suggested that rather than considering the minimum flow required by the environment, in order to limit degradation, the issue should be considered in terms of the maximum amount of water that should be allocated to users other than the environment. In other words, what is the limit of diversion from rivers 'beyond which there is an unacceptable risk that additional extractions may degrade the environment'? The study focussed on winter diversion limits, in contrast to the more common consideration of minimum summer flows.

There were a number of common issues in the three presentations in this session. The importance of expert (or technical) panels was acknowledged as being of vital importance of to environmental flow determination, but both Michael Shirley and Mike Stewardson stressed the need for it to be focussed, structured and directed appropriately. Scale was also identified as an important issue: all of the presenters discussed the need to focus on reach-scale parameters when considering environmental flow recommendations.

Community and Management Perspectives

The afternoon session focussed on the community and management perspectives of environmental flows. There were four presentations given, with each speaker providing a different perspective of environmental flows, based on the organisation with which they were affiliated.

Craig Ingram is the Independent Member of Parliament (MP) for East Gippsland. Craig is well known for his role in campaigning for additional flows to be returned to the Snowy River. From a political perspective, the community desire for healthy rivers is the key driver of politics, and the community needs to fight for what they want. An example of this is the community 'fight' for 28% of flows to be returned to the Snowy River. It is hoped that the success of the Snowy River campaign may act as a catalyst for improved management of many other Australian rivers. The Snowy Campaign was based on a simple message: currently the Snowy has 1%; the Snowy needs 28%; the Snowy community wants 28% now, who's prepared to deliver 28%? Political involvement was critical to initiating the Snowy Rehabilitation Project, and it is likely to be needed wherever large-scale rehabilitation of rivers is required.

Costs and benefits are always important issues in politics, and the cost of restoring every degraded river in Australia is huge. Craig suggested that the approach for river restoration should be to focus on those rivers that can be 'fixed', or are in good condition and can be preserved, rather than focussing on and spending large

NEW CRC REPORT

THE CALCULATION OF STREAMFLOW FROM MEASUREMENTS OF STAGE

by

John Fenton and Bob Keller

Report 01/6

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

The main aims of the Project were to:

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

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

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amounts on money on those rivers that are severely degraded and may never 'recover'.

Irrigation aspects

Stephen Mills is the current Chairman of ANCID (Australian National Committee on Irrigation and Drainage). 'Water will flow uphill to money' is a quote Stephen used to describe the importance of irrigation water supply in the Australian economy, as a source of employment, and for local and export markets. If you have a social-economic-environmental stool and cut off one of the legs (e.g. economic), the stool will topple over. Integration of these three management facets is vital to irrigation and environmental flows. An analogy of an 'armchair expert' was used to describe the ignorance of the urban community to environmental issues relating to irrigation, and Stephen challenged the audience to 'not complain about irrigation with your mouth full'. Stephen also talked about water trading, and how this should not be used as a tool to negotiate environmental flows. Water trading should be used to provide water in areas that match the best soils with the best crop.

DNRE role

Jane Doolan is the head of the Waterways Unit within the Victorian DNRE. DNRE instigated and funded two of the projects presented in the New Methods session (New Method for Determining Environmental Flow Requirements, and Ecologically Sustainable Limits to Diversion). The role of DNRE in environmental flows predominantly involves determining and managing the level of risk related to issues surrounding environmental flows. The recent development of the science behind environmental flow concepts means that understanding the risks involved in the implementation of environmental flow determinations is a major challenge faced by DNRE.

Murray-Darling system

Trevor Jacobs is a Project Manager with the Murray-Darling Basin Commission (MDBC). Trevor outlined the history of environmental flow work that has been carried out by the MDBC over the past 11 years. The Environmental Flows and Water Quality Objectives for the River Murray Project commenced in 1999 and are ongoing. The Ministerial Council has already approved works to provide fish passage from Hume Dam to the sea. In April 2002 the Ministerial Council will consider various environmental 'flow scenarios' for the River Murray that have been developed by the project. Environmental flows in the Murray-Darling system are very complex and the MDBC is committed to finding the most feasible environmental flow options from this project, through scientific and engineering investigations, and extensive community consultation.

The Round-Up

Ian Rutherfurd, River Restoration Program Leader in the CRC for Catchment Hydrology, summarised the day's proceedings in three words: 'it ain't simple'! He outlined the evolution of environmental flows and what he perceived the future of environmental flows to hold. In the past, community perception was that water going to sea was wasted, in recent times a shift has occurred with more people thinking 'Whoa! Maybe we shouldn't take all the water'. Currently, scientific knowledge regarding environmental flow requirements is expanding rapidly and it is likely to reveal our fluvial ecosystems to be more complicated than originally thought. The 'Oliver Twist' scenario – can I have some more please? - presents an ongoing challenge to management. In the future, it is hoped that the Precautionary Principle will be applied to the allocation of water to environmental flow regimes, and these regimes will gain standing in law such that there will be a shift towards protecting environmental flow requirements.

AJWR Special Issue

If this report has whetted your appetite for more information about the cutting edge of environmental flow technology, a special issue of the Australian Journal of Water Resources on the topic is being published next month. Papers include discussions of environmental flow methods, adaptive management, expert panels, geomorphology, aquatic plants and wetlands. After 30 November 2001, the issue will only be available through the CRC Centre Office for $27.50 including GST and postage and handling. For further information contact Virginia Verrelli on 03 9905 2704.

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PROGRAM 7

COMMUNICATION AND ADOPTION

Program Leader
DAVID PERRY

The Flow on Effect – December 2001

AT A GLANCE – A SUMMARY OF THIS ARTICLE

Over the last 12 months, the CRC's communication activities have aimed to increase awareness of our research, assist end-users in understanding that research, and to enrol end-users in its development and application phases.

Why we communicate

All of the CRC's communication activities are designed to contribute to the key performance indicator of this CRC – the level of adoption of our research outcomes. Quite simply, the CRC is about changing practice in the land and water management industry to assist with more effective and efficient environmental management.

A key task in planning communication is clearly defining the purpose for the communication; why do we communicate what we communicate? Communication for awareness, for example, may prove effective in raising awareness but may not significantly contribute to adoption without complementary activities. Whilst creating awareness about our research and its potential uses is the critical first step in our strategy, our range of activities is designed to support the adoption of our research.

The CRC's strategy for communication – a simple model

To achieve our objectives, the CRC's communication activities are generally based on a simple model:

- Communicate for awareness (to increase knowledge of the research activities amongst stakeholders)
- Communicate for understanding (to describe the research and how it might benefit end-users)
- Communicate for conviction (to enrol end-users in the adoption process by demonstrating the research output is relevant to their needs and is practically based) and
- Communicate for adoption (engage end-users in planning and applying the research outcomes).

Brief highlights from 2001

During 2001, the CRC was active with its communication. I would like to quickly review some of the highlights using the above model as a guide.

Communication for awareness

Catchword is the cornerstone of our 'communication for awareness' and regular readers would recall that last month we reached the 100th issue. For the last eight years project teams have contributed articles that describe their research and outputs. *Catchword* has a subscriber database of over 1200 people and is an excellent way to keep abreast of the CRC's research and its potential applications.

This year our website has regularly recorded over 2000 different visitors each month. Over a third of them visit the site more than once. Similarly, our events notification database emails over 800 people each time the CRC has a report, seminar or publication in their area of interest.

Communication for understanding

Our Technical Seminars Series has remained a regular activity during 2001. These seminars are presented by CRC project teams and visiting researchers to promote a better understanding of our research and its application. During the year, fourteen seminars were held around Australia including four in Brisbane, four in Canberra and six in Melbourne.

CRC staff are also regular presenters at seminars and training days organised by CRC Parties and other collaborating professional groups such as the River Basin Management Society, the Institution of Engineers, and the Stormwater Industry Association. Regular *Catchword* readers would also be aware that the new 'CRC Water Forum Seminar Series' also commenced this year with seminars held in Melbourne, Canberra and Brisbane.

As well as producing eight reports and a working document, the CRC was also involved in a collaborative project with the Bureau of Meteorology to produce new Evapotranspiration Maps for Australia. CRC staff also made a significant contribution to the Third Australian Stream Management Conference (held in Brisbane during August 2001) and published the conference proceedings.

Communication for conviction

Twelve CRC workshops were held around Australia. These were designed to assist key end-users in developing skills and confidence in CRC research outputs. The workshops for this year included the highly successful Environmental Management Support System (EMSS) series in Brisbane, the Stochastic Hydrology Workshops targeting middle and senior managers in Melbourne and Brisbane, and the Urban Stormwater Decision Support System (MUSIC) training days (also in Melbourne and Brisbane).

WEB SEARCH ENGINE UPGRADED

The CRC's website search engine has recently been upgraded and is now able to search Adobe pdf files.

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Over 1200 people receive *Catchword* each month.

Communication for adoption

Each CRC research program team has developed strategies and action plans targeting the key stakeholders and their requirements. These strategies will be further developed in conjunction with stakeholder group representatives, and particular end-users.

In May this year we were one of three CRCs to be given a CRC Association Excellence for Technology Transfer Award. This award does support our belief that our mix of communication activities leads to adoption efficiently and effectively.

Conclusion and thank you

With this brief overview of our communication activities for the year, I trust you share my opinion that 2001 has been a very productive and rewarding year for the CRC. Our communication activities are planned and delivered by project team members across the research programs with strong support from the Focus Catchment Coordinators and the Education and Training, and Communication and Adoption Programs. To all those colleagues inside and outside the CRC who have contributed, I thank you for your continued commitment and skills.

Thanks too to all those who participated in CRC activities this year or were readers of our publications and gave us valuable feedback about our research.

I have no doubt that next year will be equally busy and exciting. Until then, please have a safe and enjoyable Christmas and New Year break.

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POSTGRADUATES AND THEIR PROJECTS

Our postgraduate for December is:

Kate Browning

A native of Canberra, I finished my schooling in Sydney and gained a BSc (Hons) at New South Wales University in 1995. From my childhood in the pristine environment of Canberra I developed a love of things natural and for my Honours project I chose to study water, a precious commodity. I studied the efficiency of a constructed wetland treating stormwater in a newly developed housing estate in Penrith, Sydney, and started to see this as a career direction. After completing my studies I began work at the NSW Department of Land & Water Conservation as a Cadet Hydrographer, Sydney/South Coast Region (1996-1997) and enjoyed a few years as the Water Quality Officer, Murray Region (1997-2000).

After my spell in the "bush" I was keen to continue my formal education and late in 2000 I was lucky enough to be offered a MPhil Scholarship with the School of Environmental Engineering at Griffith University, Brisbane. My project, funded through the Natural Heritage Trust and Brisbane City Council, is to investigate the use of native macrophytes in sub-surface flow wetlands. The broad aim of my research is to determine the effectiveness of four native macrophyte species at nutrient removal in a wetland receiving secondary treated effluent in South East Queensland.

Conventional tertiary wastewater treatment for nutrient removal is often expensive to construct and has high maintenance costs. Constructed wetlands offer an alternative for tertiary wastewater treatment. Macrophytes can play a significant role in constructed wetlands for wastewater treatment. In Queensland, over 60 species have been used in surface-flow wetlands, but only four species have been used in sub-surface flow (gravel bed) wetlands. There is a clear need to determine the suitability of more Australian native plants for use in these constructed wetlands.

My study in Brisbane uses a pilot-scale wetland, receiving secondary treated effluent, to assess the suitability of four native macrophyte species. The pilot site, situated at the Oxley Wastewater Treatment Plant (WTP) in Brisbane, is a horizontal sub-surface flow wetland, consisting of four equally sized cells. The experimental design involves four different substrate treatments:

- new 5mm gravel;
- old 5mm gravel (previously planted with *Phragmites australis*);
- old 20mm gravel (previously planted with *Phragmites australis*) and;
- old 20mm gravel (not previously planted)

The four native macrophyte species planted are:

- *Baumea articulata* "Jointed Twigrush";
- *Carex fascicularis* "Tassel sedge";
- *Philydrum lanuginosum* "Frogsmouth" and;
- *Schoenoplectus mucronatus*.

My aims are to undertake a mass balance study to determine the nutrient removal capabilities of the four native macrophyte species. I am studying the effects of gravel size and organic matter accumulation on plant biomass, growth and removal of nutrients and suspended solids, and will also investigate the effectiveness of cropping on plant re-growth and nutrient removal. I also hope to assess the suitability of these macrophytes for commercial use.

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CRC PROFILE

Our CRC Profile for December is:

Harald Richter

The Early Days:

My story began over thirty years ago in a medium-sized town in Germany. It didn't take long for me to work out that I wanted to be a meteorologist. I think I forged those plans before I turned 10. I also had a tendency to move as far away from home as I could, probably to see what "the other end" looked like. Accordingly, I moved from the northwest of Germany to the southeast to spend my undergraduate years at the University of Munich.

The Monash Days

Soon afterwards I extended my "other end" concept to the planetray scale. In 1991 I went to Monash University for postgraduate studies at the Centre for Dynamical Meteorology. I worked in a physical laboratory generating dye vortices inside a water-filled tank that was spinning around on a rotating table. I reproduced those vortices numerically and was glad to see both types of vortices looked alike.

I must have enjoyed the student lifestyle on campus as I decided to continue at Monash for my PhD research. This work climbed to respectable heights with an investigation of the interface between the lowest layer of atmosphere (troposphere) and the layer above (stratosphere). To my (initial) astonishment this interface, the "tropopause," can be massively distorted, pulled down and folded in a process known as "tropopause folding." My PhD research was concerned with the construction of a simple model describing this folding process. I was part of a different CRC (Southern Hemisphere Meteorology) then.

The Stormy Days

In 1998 several major lifestyle changes collapsed into a single moment. Offspring arrived days before my graduation, which in turn took place days before moving to New York State for a new job as a postdoctoral researcher at the State University of New York in Albany. For nearly two years I could indulge in the nucleus of my passion for the atmosphere - severe convective storms (storms that often produce large hail, strong winds and, occasionally, tornadoes). My research focused on the initiation of these unusually strong thunderstorms, i.e. the stage from no cloud to initial cloud. The tool I used was one of a handful of Fortran-based monsters, commonly known as numerical weather prediction models. During late May/early June I also had my fair share of "storm chasing" in the Southern Plains of the United States. No, it is not like the movie "Twister!" I did not see any flying cows, I did not see Helen Hunt, but I did see a grain mill in Texas collapse in slow motion as a violent tornado engulfed it.

I continued my research on the initiation of severe atmospheric convection at the National Severe Storms Laboratory (NSSL) in Oklahoma during 2000. I lived under some wide open skies, listened to country music, but there was still no sign of flying cows or Helen Hunt.

Nowadays

Having started in the stratosphere, my research eventually hit the ground earlier this year when I joined the Bureau of Meteorology Research Center (BMRC) in Melbourne. I am now concerned with the improvement of the land surface scheme (LSS) within one of the operational Australian weather prediction models, the Limited Area Prediction System (LAPS). From a meteorological point of view, the LSS delivers heat and moisture fluxes for the lower atmosphere. These fluxes then influence the surface temperature, the wind field, the model's rainfall generation mechanisms and basically everything else in the model.

It seems that, once again, after my work involving the upper end of the troposphere, I have switched to the "other end."

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WHERE ARE THEY NOW?

Report by John Tilleard

My before, during and after

It's all getting a bit hazy now. Somewhere back in the mid 90s, an idea took root that there must be more to professional life than running a consulting practice about rivers and catchments. Wouldn't it be good to apply practical understanding and theoretical skills to something that I thought was useful rather than helping someone else with their agenda? Wouldn't it be a fine idea to spend all the time I thought was needed to investigate an issue properly rather than be driven by the dictates of someone else's budget? Wouldn't it be nice to put "making a contribution" in front of "making a buck" for a while?

And so the plot took shape!

Now, quite a number of years (don't count) later, Ian Drummond and Associates has been acronymised to ID&A, I'm about to take my walk across the ceremonial PhD stage, and lo, I'm back running a consulting business about rivers and catchments.

Ah, but so much wiser!

- I have explored a way to put to use my understanding of the links between hydrology, hydraulics and river morphology ..... and also how to coach a school sports team!
- I found a research topic that would help with the trade-off between environmental and consumptive water allocation ..... and I explored corporate governance on boards of public and private organisations!
- I developed and tested a new approach to analysing river channel change downstream of dams and diversions ..... and I learnt to live with the good and the bad of academia, academic institutions and academics!

Overall, a great few years. I enjoyed my sojourn (partly) out of the consulting whirl, but I have to say that I found the general state of our tertiary education system worrying, particularly the ramifications of funding difficulties.

So where am I now?

I live in Sale in Gippsland. I am a Director of Fisher Stewart, the successful consulting business that now owns ID&A. I am working on projects on the Murray River, in East Timor and Vietnam. And, for the present, I am managing ID&A again!

I am pleased with the prospect that my research is already helping in several projects. I hope that it may contribute to a better understanding of the changes to expect in a river channel when the pattern of the flows is altered by dams, diversions, catchment change or climatic change.

Thanks to all those who helped before, during and after. Congratulations to the CRC for Catchment Hydrology for surviving and thriving, and for supporting and integrating programs of research that are relevant to current and future natural resource management problems.

I will value the opportunity to continue to be involved in your work.

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COOPERATIVE RESEARCH CENTRE FOR

CATCHMENT HYDROLOGY

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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
Melbourne Water
Monash University
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