NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

CATCHWORD

NO 89 NOVEMBER 2000

A NOTE FROM THE DIRECTOR

Professor
Russell Mein

Inside...

FORMAL PARTICIPATION IN THE CRC

Readers of *Catchword* would know that the CRC is a cooperative venture of the fourteen organisations (or CRC Parties) listed each month on the back cover. These bodies represent a quite wide variety of interests and activities, brought together by their common interest in land and water issues, and the belief that a cooperative approach will achieve more than individual effort.

In the formal sense, it is the CRC Parties who are the co-signatories to the Commonwealth Agreement, which sets out the objectives of the CRC, and the commitment of each organisation (and the Commonwealth's) to the Centre over its seven-year life. The purpose of this article is to point out that the CRC is not a 'closed shop'; other organisations can join.

In the 'old' CRC, we had one organisation coming in initially as an Associate and then becoming a Party about five years into the CRC term (and staying for the new CRC). Three others joined as Associates; one of these is now a Party.

New and revised categories of membership

At its Meeting last August, the CRC Board approved the arrangements for formal linkages to the current CRC. It set a new category "Research Affiliate", modified the Associate category, and retained the Party category. These categories are described briefly below.

CRC Research Affiliate

There has been a high level of interest by a number of research groups in the CRC's focus on research at 'whole-of-catchment' scale, and a shared desirability to link our research with theirs through formal arrangements. A key component of such a relationship would relate to the sharing of intellectual property (eg. data, research outcomes) under agreed terms. A further requirement would be for the joint activities to be consistent with CRC objectives (as expressed in our Business Plan).

A Research Affiliate would likely :

- be a research group whose research complemented ours, where linkage would provide clear synergies
- have a research program of sufficient size (say $100k per year) in the area of interest
- agree to share databases with the CRC under reciprocal arrangements protecting intellectual property
- publish outcomes jointly as appropriate

Hence, the intention is that the CRC would not provide cash funding to the Research Affiliate, nor vice versa. Joint applications for external funds would be possible, and certainly encouraged, for activities that were clearly within the envisaged scope of CRC programs.

CRC Associate

Here, there are now two types of Associate membership – one linking participants directly to a project, the other providing a more general linkage. With the high level of inter-linkage in current projects, it was seen that a more general type of membership should be added to the project linked alternative continued from the initial CRC. The Associate alternatives are:

- Direct involvement in an approved project, entailing:
  - participation in project formulation and conduct, and a seat on the project reference panel
  - a share of project developed intellectual property in proportion to contribution (although commercialisation outcomes are subject to separate agreements)
  - access (for research purposes) to agreed intellectual property for the specified project
  - the opportunity to second staff to CRC funded projects, and a say in the choice of demonstration sites
- Broad linkages to the CRCs research projects and outcomes, including:
  - access to, but not ownership of, Centre intellectual property
  - an annual briefing
  - specialist technical advice (on a limited scale)

CRC Party

The main feature of being a CRC Party is a direct participation in setting the research directions and priorities, and a share in the technology exchange and outcomes from a national program aimed at major land and water management issues.

Parties also have:

- access to and a share in ownership of all intellectual property developed by the CRC
- direct participation in CRC projects, and listing on CRC documents
- the opportunity to second staff to CRC funded projects, and a say in the choice of demonstration sites
- the potential for providing major influence in the development of the CRC research agenda and priorities
- the opportunity for information exchange and briefings by the CRC on major industry issues

CRC PUBLICATIONS LIST

Reports, videos and software, available from the CRC, are listed in our 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

www.catchment.crc.org.au

All prices listed include GST, postage and handling.

An invitation …

The CRC Board is keen to widen the sphere of influence of the CRC, to exploit research synergies, and to increase the level of adoption of its research outcomes. Closer links with 'like-minded' research and industry organisations will be actively pursued over the coming months.

We are looking forward to contacting a number of organisations directly to seek linkages; meantime, we have summary sheets setting out details of each category of membership, and would be glad to supply them on request.

I'd be happy to talk to anyone who'd like to discuss these options further. If interested, please give me a call on 03 9905 2704.

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PROGRAM 1
PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

Report by Rob Vertessy

Contributions by visiting scholars

Over the last few years the CRC for Catchment Hydrology has had a steady stream of overseas graduate students joining us for extended periods to undertake research projects. Most of the students come from Europe and the United States where they are enrolled in Masters or PhD programs. Generally, they come because we have useful data sets or models that can help them in their research. Many have come through my own lab at CSIRO and I have enjoyed interacting with each and every one of them.

This year, the Predicting Catchment Behaviour program has hosted two overseas students at CSIRO in Canberra. Both students undertook challenging projects that resulted in very useful outcomes for our CRC, so I'd like to take this opportunity to acknowledge their efforts and briefly describe their work to you.

Modelling the effects of pine afforestation on water yield

Klaus Hickel, an MSc candidate from the University of Stuttgart, Germany (working under Prof. Andras Bardossy), spent six months working with me on the effects of pine afforestation on catchment water yields. Klaus began by examining the hydrometric record for the Tumut paired catchment experiment, set up by NSW State Forests and CSIRO in 1988.

The Tumut catchment experiment comprises two catchments; Kileys Run (135 ha), which is an improved pasture control, and a similar catchment adjacent to it, Redhill (195 ha), originally under pasture but afforested with pines in 1989. Surprisingly, given the high profile of afforestation, this experiment is Australia's sole-surviving catchment treatment experiment designed to quantify the effects of pine afforestation of grassland in a commercial plantation region.

In his work, Klaus spent a lot of time cleaning up and gap-filling raw data and then performed some analyses to measure the impact of the afforestation on water yield. *Figure 1* shows how water yield from Redhill has steadily decreased since afforestation, relative to flows from the undisturbed Kylies Run catchment. Klaus estimated that the average annual yield reduction in Redhill for the period 1995-1999 was 182 mm, during which time the mean annual rainfall was 850 mm. This drop in yield is a little lower than observed from similar experiments in New Zealand and South Africa, though we expect further decreases as the pine plantation matures.

To anticipate how low the Redhill yields may go (and to determine their persistence and inter-annual variability), Klaus has been using the Topog model. Having successfully calibrated the model on the twelve years of field data we have available, he is now forecasting flow trends for the whole plantation life cycle (assumed to be 40-50 years). The Topog model simulations will also show how the seasonality of flows changes in response to afforestation.

The use of pedotransfer functions in catchment runoff models

Joe Sobieraj, a PhD candidate at the University of Cincinnati, Ohio (working under Associate Professor Helmut Elsenbeer), spent two months working with me on the use of pedotransfer functions (PTF's) in catchment modelling.

In hydrologic modelling, PTF's are used to estimate saturated hydraulic conductivity (Ks) from more easily measured soil parameters such as texture, bulk density, porosity and organic content. Ks is one of the most sensitive parameters in hydrologic models but also one of the hardest to measure. Because of this, Ks is rarely measured directly and modellers are increasingly relying on PTF's to estimate it.

Joe tested the ability of nine published PTF's to estimate Ks values for soils of the La Cuenca catchment, located in the lowland tropical rainforest of the Selva Central of Peru. This site was chosen because Ks had been directly measured at many sites in the catchment and we had already successfully simulated storm event runoff generation in the catchment using the Topog model. In addition to testing the performance of these PTF's, Joe wanted to know what the consequences would be of using Ks values from PTF's in a catchment model. Our previous Topog modelling work at La Cuenca (based in field measurements of Ks) gave him a good basis to work from.

Joe found that for the permeable surficial soils (0-10 cm depth), all but one of the PTF's underestimated Ks by more than one order of magnitude. For the far less permeable subsoils (10-40 cm depth), Joe found that all but one of the PTF's overestimated Ks by variable amounts. Not to be deterred by the lack-lustre performance of these PTF's on the La Cuenca soils, Joe repeated our La Cuenca modelling runs using the PTF estimates of Ks. Unsurprisingly, the model performed quite poorly using these estimates, relative to our published runs based on actual field measurements.

Joe concluded that PTF's needed a lot more work if they are to be used in catchment runoff modelling, and that modellers currently using them should be circumspect about their results. Joe has written up the results of his study and has submitted them to the Journal of Hydrology for inclusion in a forthcoming special issue on PTF's.

Thanks

Klaus and Joe have now both returned to their home bases and are continuing with their studies. I thank them both for their valuable contributions to our research effort and wish them all the very best in their careers.

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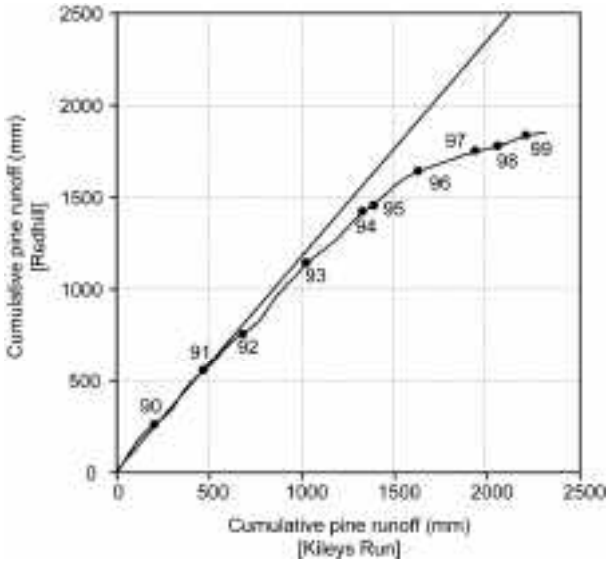

Figure 1: Double-mass plot showing the impact of pine afforestation on water yield from the Redhill catchment, near Tumut. Flows at Redhill are declining relative to those from the undisturbed control catchment, Kylies Run.

BRISBANE TECHNICAL SEMINAR

AN ENVIRONMENTAL MANAGEMENT SUPPORT SYSTEM FOR THE SOUTH EAST QUEENSLAND REGION

SPEAKERS:

Dr Rob Vertessy, Joel Rahman, and Sue Cuddy
CSIRO Land and Water;

Dr Francis Chiew and Dr Phil Scanlon
The University of Melbourne;

Dr Fred Watson
California State University, Monterey Bay.

Monday 4 December 2000
Start 9.00 am - 12 noon

Venue:
80 George Street
Brisbane

For further information contact
Mary-Lou Clarke on
tel: 07 3875 5394

NEW CRC SOFTWARE

AQUACYCLE

Aquacycle is a daily urban water balance model which can be used to investigate the use of locally generated stormwater and wastewater as a substitute for imported water. Dr. Grace Mitchell developed Aquacycle during her postgraduate studies.

The Aquacycle includes the CD-ROM and a complimentary copy of the CRC Industry report 'The Reuse Potential of Urban Stormwater and Wastewater'.

A copy of Aquacycle can be ordered through the Centre Office. Users are requested to sign a User Agreement and a manufacturing and distribution cost of $27.50 applies to orders.

For further information visit www.catchment.crc.org.au/products

PLEASE NOTE: The Aquacycle software is currently only available for IBM compatible computers.

PROGRAM 2

LAND-USE IMPACTS ON RIVERS

Program Leader

PETER HAIRSINE

Report by Mark Littleboy

Project 2.3 - Predicting the Effects of Land Use Changes on Catchment Water Yield and Stream Salinity

The objective of this project is to predict the regional scale impacts of land use changes on mean annual and seasonal catchment water yield, groundwater recharge, and stream salinity. In this report, one expected outcome of the project, viz. increasing our capacity to estimate groundwater recharge under different land use and climate conditions, will be discussed.

Within Project 2.3, there is a heavy emphasis on the relationships (perhaps now infamous) developed by Holmes and Sinclair (1986) and further explored by Zhang et al. (1999) as presented in *Figure 2*.

Holmes and Sinclair relationships

These relationships are underpinned by an extensive worldwide database of experimental rainfall and runoff data. In order to infer recharge from these types of functions, the assumptions behind them need to be understood:

- They were derived from measured rainfall and runoff data from small catchments and assume evapotranspiration (ET) = Rainfall – Runoff;
- They ignore changes in soil water content or recharge; and
- As such, the recharge "signal" is hidden within the relationships.

A task of Project 2.3 (Task 3) is to partition the non-transpired water into runoff and recharge pathways. But, this partitioning cannot be inferred directly from the relationships, nor can it be calculated from the original dataset. Consequently, a more mechanistic or physically-based approach is required to quantify the runoff and recharge pathways. With the insight gained from a more rigorous modelling study, we will be in the position to develop a simpler and more generic recharge model that will complement the Holmes and Sinclair type relationships.

Proposed approach for Project

The proposed approach is to apply unsaturated zone water balance models to quantify the runoff and recharge pathways under different climatic regimes, soil type, land uses and topography. But the dilemma is that many unsaturated zone models are one-dimensional, and by definition, must be and have been shown to be, poor predictors of recharge in many real-life situations. It is rare that the "drainage below the root zone" estimate from a 1-D soil water model will be similar to the recharge estimated from a hydrogeological perspective. Differences of an order of magnitude are fairly common. In many studies, the absolute value of the "drainage below root zone" is not used. Instead, the relative changes between estimated drainage from different land uses are used to determine scaling factors and applied to the hydrogeological estimate of recharge.

Limitations of one-dimensional models

But why is this the case? 1-D models commonly ignore lateral subsurface movement of water which can be a major pathway in many landscapes. If you assume a situation of a texture contrast soil on a hillslope, significant interflow may take place. But 1-D models that assume vertical movement of soil water only, will unrealistically

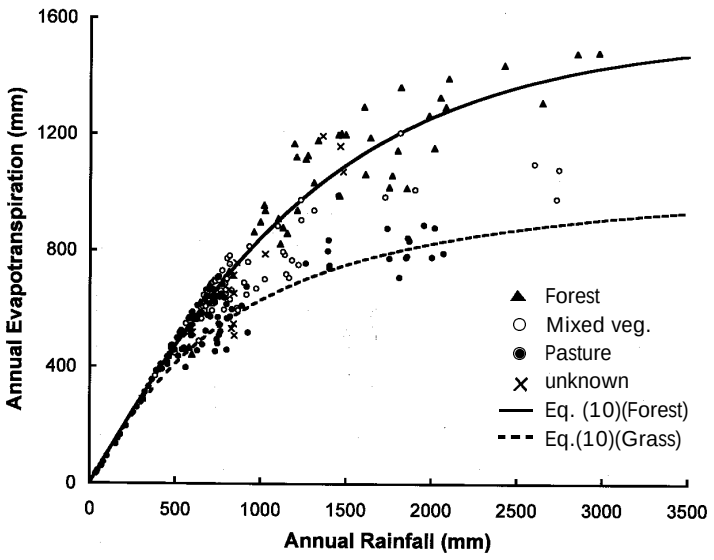

Figure 2. Relationship between annual evapotranspiration and rainfall for different vegetation types (Zhang et al. 1999)

pond this excess water above a less permeable soil layer, and either allow the plant to extract the water, hence overestimating ET, or allow the water to slowly percolate downwards, hence over-predicting drainage below the root zone. A complex interaction between soil properties and water use parameters determines which pathway is over-predicted.

Two-dimensional models with a simpler approach

There are many examples of 2-D models (e.g. TOPOG, HYDRUS 2D) that simulate two-dimensional water flow in a landscape, but these types of models are too complex and data intensive to apply on the scales required within Project 2.3. So a simpler methodology is required.

The approach to be applied in Project 2.3 will be based on the outcomes from recharge modelling projects that are part of the NSW State Salinity Strategy. The NSW Department of Land and Water Conservation is constructing a 2-D framework for recharge modelling that can be applied at all scales from catchment to statewide. In order to partition excess soil water into lateral and vertical pathways, insight will be gained from a comprehensive desktop scoping study of water movement using complex and physically-based 2-D models. From this study, we will be able to determine the relative partitioning coefficients for lateral vs vertical water movement for combinations of climate regimes, soil type, land use and landscape position. We will then be in a position to use these coefficients in a simpler bucket-type water balance model that can be more readily applied across different geographical scales.

Improved estimates of recharge

Based on this new modelling framework under development, we can get better estimates of recharge. These estimates can be used within Project 2.3 to build generic relationships to adjust the Holmes and Sinclair type relationships and partition the non-transpired water into the runoff and recharge pathways.

It is an unusual hierarchy of modelling. We will be using a complex 2-D model to obtain parameters to populate a simpler modelling approach. Then from this simpler modelling approach, we will develop an even simpler and generic model to complement the Holmes and Sinclair relationships. This end-product will provide a simple methodology that can be applied to estimate recharge. Given the widespread use of the Holmes and Sinclair type model, mainly due to its simplicity, we would hope that a similar approach to isolate the recharge "signal" currently hidden within the functions would also be suitable for widespread application.

Benefits from collaboration

Without the additional resources dedicated to the NSW State Salinity Strategy recharge projects (3 FTEs over 2 years), it would not have been possible to apply a physically-based approach to develop a simpler recharge model within Project 2.3. This demonstrates the importance and benefits of non-CRC projects to CRC for Catchment Hydrology activities. It is also an indicator of why CRCs can be beneficial for inter-agency collaboration, and why we are all here.

References

Holmes J.W. and Sinclair J.A. (1986). Water yield from some afforested catchments in Victoria. Hydrology and Water Resources Symposium, Griffith University, Brisbane. The Institution of Engineers Australia.

Zhang L., Dawes W.R. and Walker G.R. (1999). Predicting the effect of vegetation changes on catchment average water balance. CRC for Catchment Hydrology Technical Report 99/12.

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NEW CRC PROGRAM SOFTWARE

Extreme Design Rainfalls for Victoria

The crcforge-extract computer program has been produced to facilitate the extraction of rare to extreme rainfalls from the (at present, Victorian) database, and to present the information in forms needed for hydrologic design.

For further information see our website at www.catchment.crc.org.au/news

To obtain a copy of crcforge-extract contact Virginia Verrelli at the Centre Office on 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au

WHAT'S HAPPENING WHEN?

FIND OUT ABOUT CRC EVENTS BY EMAIL

THE CRC WILL NOTIFY YOU BY EMAIL OF AN UPCOMING CRC EVENT IN YOUR AREA OF INTEREST.

You can register to receive this information through our website - click on 'Catchword' and then 'subscribe'

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

PROGRAM 3

SUSTAINABLE WATER ALLOCATION

Program Leader

JOHN TISDELL

Report by Gary Codner

The Need for Sustainable Water Allocation

Current national issues

The debate over the Snowy River flows and the recent COAG adoption of the National Action Plan on Salinity and Water Quality give an indication of the magnitude and importance of water allocation issues within Australia. These examples also highlight the background for the CRC's program on Sustainable Water Allocation (Program 3).

Snowy plan

In October 2000 the Victorian and New South Wales Government's committed $300 million to repair leaking irrigation systems and return water savings to the Snowy River. The Snowy Plan will likely result in reducing excess water use across northern Victoria and Southern NSW. It will also add pressure to reform irrigation pricing and result in increased interstate trading across the border. An independent body has been proposed to oversee the 'purchase' of water efficiency savings in the Murray and Murrumbidgee valleys.

Salinity and water quality

The Federal Government has committed $700 million, to be matched with funds from the States and Territories, towards addressing salinity and water quality problems in Australia. Part of the plan will involve a "reform of pricing, property rights and regulatory instruments for land and water use". Property rights for water resources will be separated from property rights for land title. This will enable trading systems for water resources to be pursued so that higher value uses are achieved, as well as to facilitate provision of water for the environment.

Modelling the Murray – environmental and operational needs

The Murray-Darling Basin Commission is looking to model the River Murray system on a daily timestep instead of the monthly timestep currently used. Increased demands on the system have resulted in a stressed riverine ecosystem, and the greater emphasis on environmental management of the system has prompted a shift to the daily timestep. The new model will be used for planning studies as well as to form the basis of daily operation of the system.

Interaction of models for water allocation

The above shows why the water allocation program is topical and important, and in particular indicates the need for considering the interaction of water balance, climatic and economic models as the core of research in CRC Project 3.1: Integration of water balance, climatic and economic models.

A number of sub-projects have been developed for Project 3.1, aimed at researching a number of key knowledge gaps identified at a workshop held on 27 July 2000. Several of the sub-projects are scoping exercises to determine what the issues are, if any, and therefore the parameters for further work. Examples of this relate to modelling the effect of climatic and socio-economic factors on crop planting and water behaviour as well as on water trading behaviour.

Issues for further work

The workshop placed considerable importance on investigating modelling efficiency, sensitivity and modelling errors.

- Representation of systems

  Typical rural water supply systems may extend over large areas supplying water to many users. The simulation of these systems requires efficient representation of the important physical and operational features of the system, the major inputs and demands, and other relevant system characteristics.

- Modelling demand and other factors

  Aggregation and dissagregation related to water demand often cause modelling problems. There are also many unresolved questions on how sensitive the simulation results are to the simplified representation of specific modelling factors (e.g. time step, flow routing method, loss functions, variation in irrigation behaviour).

- Errors in model data/output

  In addition, the question of how errors in basic data, modelling assumptions or model representations of real system characteristics translate into errors in the model outputs is of considerable interest to model users.

Improved knowledge of the uncertainties in modelling results would form a valuable input into water management decision processes.

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PROGRAM 4

URBAN STORMWATER QUALITY

Program Leader

TONY WONG

Report by Tony Weber

Best Management Practice Evaluation in Brisbane City or How Good is That SQID?

Urban stormwater quality is now a major issue of concern for governments and the community. Various studies from around the world have identified urban stormwater runoff as a primary polluter of creeks, rivers and marine environments. The Queensland State legislative framework has been amended accordingly: the Qld Environmental Protection Act (1994) and its subordinate Environmental Protection (Water) Policy (1997) have placed new responsibilities on Local Authorities to manage the impacts of stormwater on receiving waters under their jurisdiction.

In response to this issue, in 1994, Brisbane City Council established a Stormwater Quality Monitoring Program to ascertain pollutant export from land uses common throughout the city. This was complemented in 1998 by a Stormwater Quality Improvement Device (SQID) Monitoring Program to establish the contaminant removal efficiency of commonly used control devices.

SQIDs Monitoring Program - Stage 3 (1999-2000)

Three types of SQID have been monitored as part of Stage 3 of the Monitoring Program, including:

- two Ecosol Units (at Manly and Nudgee);
- an CDS unit (at Calamvale); and
- a constructed wetland (at Cressey St, Wavell Heights).

The objectives of the program were to:

- determine the type and amount of contaminants removed by each unit;
- determine the percentage reduction in predicted annual exports of TSS, TN and TP achieved by each type of SQID;
- determine the particle size distribution of sediment particles trapped by SQIDs;
- determine performance objectives for various types of SQIDs in the Brisbane context;
- determine the quality of trapped, stagnant water in SQIDs and the potential for environmental harm to be caused from a 'first flush' effect; and
- determine the mosquito breeding potential of each SQID type.

While no statistically valid conclusions can be drawn from most of the data sets obtained to date, a number of qualified statements can be made:

Water Quality

- The below ground GPTs, can be capable of reducing total suspended solids and total phosphorus concentration in wet weather events depending on the nature of the event.
- There is a possibility of a first flush of high levels of nutrients from the below-ground units at the commencement of a storm event.
- There is a potential to release some previously stored material from below-ground units, depending on the nature of the material trapped and the characteristics of the wet weather event.

Constructed Wetland

- Biological assessments identified that the Cressey Street wetland provides ecological benefits in addition to its primary function of removing pollutants from stormwater.
- The results of the community survey on the Cressey Street Wetland identified a general acceptance of the wetland concept by the community.
- There is a reduction in faecal coliform levels and total phosphorus concentrations downstream of the wetland during dry weather flow.

Mosquito Monitoring

- Mosquito larvae were not detected in the four SQIDs monitored.

Accumulated Material

- All three SQIDs trapped sediment ranging from silts and clays through to sands and fine gravels (up to 2.36 mm)

While no statistically valid conclusions can be drawn from most of the data to date, the results do provide significant scope for defining future monitoring of SQIDs in Brisbane. The results will enable Brisbane City Council to further refine its study needs, both in the traditional facets of water quality and trash, as well as the more diverse areas of study such as biological monitoring.

SQIDs Monitoring Program - Stage 4 (2000 - 2001)

From the results of the previous monitoring stages, the Stage 4 Monitoring Program builds on the previously collected data and contains revisions to enable data collection to satisfy the appropriate objectives in Program 4 of the CRC.

The following table summarises the monitoring program for 2000/2001. Items underlined in the text indicate new sites or parameters for Stage 4

CRC work

This program has been developed using the draft monitoring protocols being developed by the CRC as a guideline and researchers from the CRC have been involved in developing the current program. Please note

NEW CRC TECHNICAL REPORT

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

QUESTION FOR THE CRC?

The CRC website Forum is now available for you to use at www.catchment.crc.org.au/forum

The Forum aims to assist you in understanding the CRC's research outcomes and their application by providing a direct communication link to the resources of the CRC for Catchment Hydrology.

You are welcome to use it anytime to answer your questions or to post requests for information.

Information on how to use the Forum is given on our website.

DEVICE	LEVEL 1 MONITORING	LEVEL 2 MONITORING	LEVEL 3 MONITORING
CDS P-3018 Golden Ave, Calamvale Ecosol RSF 6000 Tuberose Pl, Calamvale	• Inflow, outflow and by-pass discharges. (due to its configuration, bypass discharges cannot be determined for the Tuberose Place Ecosol). • Continuous water levels within the units. • Volume and wet and dry weight of trapped gross pollutants and sediment. • Construction and life cycle cost. • Maintenance requirements and operating cost. • Catchment characteristics.	• Percentage of inorganic and organic material trapped. • Wet weather inflow/outflow TP, TN, TSS concentration. • Nutrients contained in trapped sediment. • Particle Size Distribution (PSD) of trapped sediment. • Dry weather inflow/outflow TSS, TP, PO4, TN, NOx, pH, Ammonia conc. • Dry weather TP, PO_4, TN, NOx, pH, NH_3 at several depths within the unit • DO and temp upstream within and downstream of the trap (field measurement only, through the depth profile).	• Wet weather inflow/outflow, particle size distribution and settling velocity distribution. • Composition of anthropogenic gross pollutants trapped. • Amount of gross pollutants bypassing the unit.
Ecosol - Cambridge Pde, Manly	• Inflow, outflow and by-pass discharges. • Continuous water levels within the trap.		
CDS - Bicentennial Ave, Boondall		• Dry weather sampling of water within the unit and the hydrocarbon absorbent for analysis of petroleum hydrocarbons.	
Sediment Basin (location to be decided)	• Construction and life cycle cost. • Maintenance requirements and operating cost. • Catchment characteristics.	• Wet weather inflow/outflow TSS conc.	
Grass Swale (location to be decided)	• Inflow, average velocity. • Construction and life cycle cost. • Maintenance requirements and operating cost. • Catchment characteristics.	• Simulated Wet weather inflow/outflow TP, TN, TSS conc.	

that this program has not been finalised at the time of writing and some changes to the parameters may need to be made. Also, there is the potential to evaluate a Humeceptor as part of this program and this is being investigated further.

Next steps

It can be seen from the above monitoring program that this program entails some comprehensive evaluation of various types of best management practices. The intention from this program is to develop performance criteria for these devices that can then be used in modelling packages (such as the CRC's Urban Stormwater Quality DSS), to allow adequate assessments of the effects of these devices to be made. From the results, further refinements to the overall BCC SQIDs Design and Construction Program are also being made. These include site selection, maintenance procedures and design modifications.

For further information on Brisbane City Council's SQIDs Monitoring Program, please contact the author.

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PROGRAM 5
CLIMATE VARIABILITY

Program Leader
TOM McMAHON

Report by Graham Mills

GEWEX projects relevant to Project 5.1

Modelling of surface hydrology

CRC Project 5.1: *Modelling and forecasting hydroclimate variables in space and time* has as one of its major aims to improve the modelling of surface hydrology in the Bureau of Meteorology's numerical weather prediction (NWP) schemes. The focus of this work is to complement the Bureau of Meteorology Research Centre's (BMRC) existing model development by using hydrological data sources to validate and refine the modelling of land surface processes. This will include the use of existing and targeted soil-moisture measurement programs carried out jointly with Project 1.2, and other sources of data from the hydrological, agricultural and remote sensing communities, as well as those data currently used in the NWP systems.

Initial focus will be on the Murrumbidgee River Basin, but it is intended to extend the project to the whole Murray-Darling Basin as the project develops. The outcomes of the work will include improved forecasts of surface hydrological parameters from the Bureau's NWP systems, improved NWP forecasts as a whole, and a move towards a full hydrologic budget of these major river basins.

GEWEX

The Global Energy and Water Cycle Experiment, GEWEX, was initiated to observe and model the hydrologic cycle and energy fluxes in the atmosphere, at the land surface, and in the upper oceans. It is an integrated program ultimately leading to the prediction of global and regional climate change. There are a large number of projects under GEWEX – a series of radiation projects, a series of modelling and prediction projects, and, of particular relevance to Project 5.1, a series of hydrometeorology projects coordinated by the GEWEX Hydrometeorology Panel (GHP).

The focus of the GHP is to demonstrate skill in predicting changes in water resources and soil moisture on time scales up to the seasonal and annual. A series of coordinated observation and modelling studies - Continental Scale Experiments (CSE's) have been established. These include the Mississippi Basin (GCIP), the Baltic Sea (BALTEX), Asia (GAME), Amazonia (LBA), and the McKenzie River Basin (MAGS). Details of all these projects can be found by following links from the GEWEX address at http://www.gewex.com/.

Continental Scale Experiments (CSEs)

To qualify as a CSE, the following criteria were required.

(i) The cooperation of a NWP centre which has implemented a state-of-the-art atmospheric and surface data assimilation procedure, and will deliver estimates of hydro-meteorological properties in a form directly comparable to observables.

(ii) A commitment of resources and personnel to pursue the development of suitable atmospheric-hydrological models, develop an atmospheric atmospheric-hydrological data management and assimilation system, and to conduct an appropriate program of numerical experimentation and climate change studies.

(iii) A regional scientific co-operation mechanism for collecting and managing hydrometeorological data sets, including satellite observations, for supporting and validating the above model developments.

(iv) A commitment to participate in the international exchange of scientific information and data in conformity with the general practice of WCRP.

(v) Collaboration with water resource agencies or related client/user groups to better utilise improved continental-scale information with the objective of addressing the problem of assessment of impacts on regional water resources.

Reference sites

While these experiments have been proceeding for varying periods, the GHP is developing a "Coordinated Enhanced Observation Period" (CEOP) to operate from 2001-2003. This will involve the development of reference sites in several of the CSE's, and emphasise simultaneous validation studies of new satellite sensors, and how to relate these satellite observations to point observations from existing sites and from what have been termed "super-sites". At these proposed "super-sites" an array of point measurements of land surface, hydrological, and atmospheric parameters would be made over an area equivalent to a satellite's "footprint" to determine how these independent observations can best be used on a larger scale where in-situ measurements are impractical.

GEWEX and Project 5.1

While the work on improving surface hydrology modelling in Project 5.1 is not part of these GEWEX initiatives, there is a great commonality of aims and methodology. There is much to be gained by our project from the CSE's and CEOP. Our project is unique in that the CRC for Catchment Hydrology's target river basins lie in a far drier climate than the other CSE's, and so the results from Project 5.1 will complement the results from the existing GEWEX CSEs.

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PROJECT DETAILS ON OUR WEBSITE

The CRC has recently published 'project description sheets' for each research project on the CRC website.

The pages (also available as pdf files) give details of research objectives, expected outcomes, target problems, key tasks, links, staff involved and contacts for each project.

Click on 'Projects 1999-2002' on our website at www.catchment.crc.org.au

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PROGRAM 6
RIVER RESTORATION

Program Leader
IAN RUTHERFURD

Report by Michael Stewardson

Catchment-scale rehabilitation and adaptive management: possible? Or a nightmare for scientists and managers alike

Inge van der Poel recently spent six months at The University of Melbourne on a scholarship from Wageningen University, Netherlands. While she was here, she assisted the River Restoration Program with a review of using adaptive management techniques for catchment management problems. This is a brief summary of her review.

Using adaptive management techniques – a review

There is increasing interest in the inclusion of experimentation as part of large-scale rehabilitation projects to allow for adaptive management.

Adaptive management has been defined as having two attributes:

- it is a response to uncertainty about the system being managed, and
- actions are designed to provide new information about the system.

In other words, it brings information back into the system, providing a broader base of knowledge with which to manage.

Comparison with traditional approaches

With traditional management policies, actions are based on existing knowledge. These actions are changed when deemed unproductive and are often based on limited data without any strategic perspective. In contrast, adaptive management promotes an experimental approach to management that acknowledges uncertainty and provides a structured approach to learning about the system being managed.

Challenges

Inge's review identified a number of challenges for catchment management agencies wishing to adopt the adaptive management approach. Two of the biggest challenges are:

- developing the commitment of management institutions and stakeholder groups to learning through an experimental approach to catchment management, and
- assessing the true level of uncertainty in the performance of adaptive management efforts.

Inge points out that despite repeated calls for adaptive management of catchments, there are few examples where it has been implemented. This suggests greater concern needs to be given to addressing the problems associated with the experimental management approach before it will be applied successfully. Whilst adaptive management of catchments is not a solution to the problems of decision-making in highly uncertain large-scale problems, it does offer a structured approach to reducing uncertainty in partnership with on-going management.

Publications

Inge and I have prepared a paper based on this review to be submitted for the next Australian Water Association conference. Given sufficient interest, we will also prepare a CRC report on the adaptive approach to catchment management.

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Report by Tony Ladson

International Aquatic Modelling Group

The International Aquatic Modelling Group met in Quebec City on October 2, 2000. Tony Ladson attended on behalf of the CRC and provides the following summary from the IAMG Coordinator Piotr Parasiewicz of Cornell University

The International Aquatic Modeling Group (IAMG) is an interdisciplinary, collaborative effort focusing on development of methods for quantitative assessment of impacts and evaluation of restoration efforts in aquatic ecosystems. On 2 October 2000, the IAMG held a technical workshop to identify emerging research priorities and to define an agenda for the emerging work program. The participants represented a broad cross section of method-developers and end-users from North America, Europe, and Australia.

Review of research

The IAMG reviewed research needs identified by end-user organisations such as the Instream Flow Council (IFC), US Fish and Wildlife Service (USFWS), American Society of Civil Engineers (ASCE), and The Nature Conservancy (TNC). Additionally, the IAMG considered priorities defined by researchers at the request of the US Environmental Protection Agency (EPA) and the Water Environment Research Foundation. Consequently, the development of a comprehensive methodological framework for definition of integrative reference conditions was declared as a top research priority.

Framework of reference conditions

A desired reference condition is the foundation for many concepts and tools used to understand and to quantify how natural conditions, processes and functions of rivers have been altered from their natural states.

The concept of reference needs to incorporate the biological, physico-chemical, and hydrological processes and attributes of running water ecosystems. The research should focus on following topic areas:

- status indicators and classification systems
- ecological potential
- functional relationships
- temporal and spatial scale
- natural variability.

Reference condition – a basis for comparison

A physical reference or a desired reference condition is the foundation for many concepts and tools used to understand and to quantify how natural conditions, processes, and functions of rivers have been altered from their natural states. The popularly applied impact assessment methods like Index of Hydrologic Alteration, the Ecosystem Diagnostic Tool, and the Index of Biotic Integrity all employ the idea of a reference against which impact and restoration can be contrasted.

From an institutional point of view, application of these and similar tools by agency scientists becomes a critical part of assessing impact, determining mitigation, and performing restoration planning in many countries of the world.

Tony is now working with Piotr and other IAMG members to draft a paper that explains research needs identified by the group.

For more information on IAMG see http://www.sintef.no/units/civil/water/iamg/iamg.htm.

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COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

The Flow on Effect – November 2000

Communication for awareness or communication for adoption?

A reflection

I have recently returned to work from five weeks holiday in Spain, England and Thailand. A break of this length has allowed me a sense of distance from the day-to-day activities of the Communication and Adoption Program and time to reflect on how well placed we are to have our research outputs integrated into land and water management industry practice.

Our effort so far

In terms of time, the 'new' CRC is almost halfway through its current round of core projects. Since July 1999 (when the current CRC commenced) there has been a continuing and significant effort in the communication of our research. By the end of October 2000 (16 months in), the CRC had published 22 technical reports, three Industry Reports, four working documents, and six videos. CRC staff have also presented 20 technical seminars and five Industry Seminars. The large number of publications and activities in such a short time reflects the commitment of CRC researchers and industry staff to the communication of the research, as well as a 'springboard effect' from the previous CRC.

Significant commitments

In rough terms, publishing these materials required around six months work from the Communication and Adoption Program alone. This estimate does not include the time spent by authors in writing the reports, drafting the diagrams, or preparing the seminar presentations (including these inputs is likely to increase the estimate ten fold). This is a significant commitment, and does not include workshops, field trips, other invited presentations or conference and journal papers they are also producing. Our CRC is very fortunate to have a group of researchers who are dedicated to cutting edge research and its delivery to industry.

Balancing publications and applications

I am very proud of our CRC's strong record of research and its communication. This aspect of our organisation no doubt contributed to our successful bid for the current CRC. There is however, a potential risk in assessing performance solely in terms of the outputs (publications from the research), and ignoring the outcomes (the application of the research). Certainly the former is a lot easier to do (and manage) and this could explain why it is common in many similar research-based organisations.

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NEW TECHNICAL REPORT

A MODEL FOR DISAGGREGATING DAILY TO HOURLY RAINFALLS FOR DESIGN FLOOD ESTIMATION

by

Walter Boughton

Report 00/15

This report addresses the task of producing 'appropriate' patterns of hourly rainfalls for the generated daily values, a process termed disaggregation.

Copies are available for $27.50 (inc. GST) from the Centre Office

PLEASE CONTACT
Virginia Verrelli on
tel 03 9905 2704 or email
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Interaction and collaboration

Our CRC relies on the interaction between the industry and research Parties to find an appropriate balance between publication and application. From a researcher's point of view, there is substantial pressure to publish scientific papers in internationally respected journals – a University's funding, for example, is directly related to this type of product. From an industry perspective however, an effective product has clear, practical implications for management, either supporting existing management practices or establishing a better practice. The collaboration between industry participants and researchers in our CRC has assisted our Parties in getting useful outcomes that meet their purposes.

Our aims in communication

Given the considerable commitment of communication resources that our CRC makes, an important question we can ask ourselves is 'what do we want to achieve from our communication?' Contemporary science communicators seeking to maximise the impacts of research ridicule the traditional philosophy of 'publish the results and it will have an effect on industry practice'. Yet the land and water management industry is flooded with publications relying perhaps on this principle for success. Certainly there is a role for reports, brochures and newsletters that raise the awareness of land and water management issues, but there are very few materials that take the next step of informing their audience of the practical application. For me, this reinforces the importance of the question 'what do we want to achieve from our communication?' Our development of the communication strategy needs to reflect our aims.

Adoption - the main goal

In the CRC for Catchment Hydrology, the answer to this question is rarely 'for awareness' alone. Our main communication goal is communication for adoption. Consequently, to deliver on our Business Plan and meet our goal of adoption of the CRC's research outcomes, we must ensure that our communication strategies raise awareness of our research in the first instance, offer practical and relevant information about its application, and include the opportunity for evaluation. If we don't, we may be a very well known CRC with little real impact on industry practice.

Review of CRC communication

Over the next few months, as part of our Business Plan, an independent consultant will be reviewing our CRC's communication activities. Their brief will be to assess our communication from a perspective of application, not publications. It will be a timely review of our efforts and I look forward to presenting the results in *Catchword* early next year.

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POSTGRADUATES AND THEIR PROJECTS

Our postgraduate for November is:

Muthukumaran Muthukaruppan

Background

Muthu has a pollution control and environmental legislation enforcement background. He has a Bachelor's Degree in Civil Engineering and a Master's Degree in Environmental Engineering from Indian Institute of Technology Madras, Chennai (formerly Madras). Muthu has been working as an Environmental Engineer with the TamilNadu Pollution Control Board, India, a statutory organisation similar to the Environmental Protection Agency in Australia.

Current research

He is currently doing his PhD on Urban Stormwater Quality at The University of Melbourne on the topic 'Identification of Quality and Size Distribution of Contaminants in Urban Stormwater'. This research forms part of Project 4.1 in the CRC Urban Stormwater Quality Program 4. Dr. Francis Chiew, Assoc. Prof. Tony Wong and Dr. Tamie Weaver are supervising his work. Aspects of his research are briefly described below

Contaminants in urban stormwater

Urban development affects storm water quantity and quality. In urban areas, a higher proportion of impervious area leads to greater runoff and urban activities contribute to the deterioration of stormwater quality. The result is progressive degradation of the environmental condition of waterbodies and aquatic ecosystems in the urban environment.

The level of pollution caused by surface runoff often surpasses the pollution loading to the surface water from sources such as treated industrial and municipal water. Urban runoff may contain significant levels of suspended solids, heavy metals, nutrients, oxygen demanding materials and pathogens. Suspended solids is the primary pollutant affecting urban stormwater quality and it is used as an important parameter in water quality characterisation. Many other pollutants have a strong association with suspended solids and so the knowledge of the characteristics and behaviour of suspended solids is particularly important in urban stormwater quality modelling and management.

Current models

Currently available stormwater quality models estimate stormwater pollution loads over different temporal and

spatial scales. Long-term pollution loads such as annual or monthly estimates provide an indication of the long-term inputs to the receiving environment. However for design and operational purposes - for example, control options for storage and high rate pollutant treatment - estimates of pollutant loads and concentrations over individual storm events (event loads) are important.

Stormwater treatment

Treatabilty of stormwater often depends on the size distribution of particulates due to the strong association of sediments with other pollutants as discussed earlier. The processes involved in the treatment of stormwater such as sedimentation, filtration, mass transfer, adsorption, diffusion and to a greater extent biochemical reaction are strongly influenced by particle size. Hence the estimates of pollutant loads or concentration levels from existing models are found to be inadequate and knowledge of the distribution of contaminants in different size ranges is important to formulate and evaluate effective treatment measures.

Influence of catchment and climatic conditions

Many authors have addressed the size distribution of solids and associated contaminant concentrations in stormwater. However, the influence of catchment and climatic characteristics, particularly, the influence of geology which supplies the basic material onto which the other pollutants adhere and the underlying processes which determine the partitioning, have not been fully studied and understood.

In this project, Muthu will be studying the relationships between particle size distribution and partitioning of the contaminants and the influence of catchment and climatic characteristics. This insight will aid the development of methods to estimate pollutant loads associated with different size ranges. It is hoped that the knowledge thus developed will assist in designing effective treatment measures, understanding the treatment processes, improving the operation and maintenance of the existing treatment systems and also provide a better understanding of the buildup and washoff process itself.

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CRC PROFILE

Report by Margaret Greenway

My interest in streams started in Loughborough, England as a child. I would go down to the "brook" with a net, jam jar and the "Observers Book on Pond Life" which I still have and use. I also watched in dismay as fields became housing estates but fortunately backyards ended about 20 metres from the creek (instead of in the middle of the creek) leaving a narrow fringe of riparian vegetation. I went onto Reading University to study geology and biological sciences. I completed an honours degree with a double major in botany and zoology.

My honours project in botany was a palynological (or "pollen distribution/dating") study of a peat bog revealing the successional changes in vegetation between the ice ages to the advent of man and crop cultivation.

My zoology project was an ecological study of the "brook" in my home town which I conducted over the three month summer holiday. I established 22 sampling stations along the 20 kilometre length from the source (a spring), through agricultural land, residential land, the town centre, industry (including Fisons Chemicals), the sewage 'farm' to its confluence with the River Soar (part of The Trent River System). Does this sound familiar Chris? (See CRC Profile Chris Carroll July 2000). I produced a Biotic Index for each station. Of course the section downstream of the sewage outfall had the lowest Biotic Index supporting only tubifid worms. I repeated the survey in 1995 during my sabbatical in the UK. The most significant change was in the last section, crystal clear tertiary treated effluent was being discharged, trout and other fish were present as well as a suite of macro invertebrates. The highest nutrient concentrations were now in the upper catchment downstream of the Country Golf Course!

Leaving aside my freshwater studies, I decided to do a research higher degree in Marine Science. My marine biology lecturer at Reading had done his PhD in the Caribbean - his magnificent slides of mangroves, seagrass meadows and coral reefs had convinced me. I applied for a Scholarship and within one month of finishing at Reading I was in Jamaica. SCUBA diving and enjoying the rum, Red Stripe (local beer) and reggae (Bob Marley lived just down the road). What a life style and yes I was awarded my PhD: A comparative study of seagrass productivity in Kingston Harbour and a Coral Cay.

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If you want information about catchment hydrology, start with our website.

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Where to next - certainly to return to the UK and do marine science in the North Sea or English Channel was not an option. I decided to take time off and travel to Australia. Back to UK to get all the necessary visas then I was off to OZ via Europe, Turkey, Iran, Afghanistan (I was probably one of the last overland travellers through Iran and Afghanistan before the political problems), Pakistan, India, Nepal, Bangladesh, Burma, Thailand, Malaysia, Indonesia. In November that year I was diving on the Great Barrier Reef with marine scientists from James Cook University observing coral spawning. I also discovered and named a new seagrass species Halophila tricostata.

After an introductory year in academia at Griffith University in the School of Australian Environmental Studies (remember the Easter Bunny Champagne Breakfast Chris [Carrol]). I spent the next six years at Northern Rivers CAE (now Southern Cross University) where I co-ordinated the Natural Resource Management course and taught 21 hours a week in subjects ranging from Fisheries Biology to Rainforest Ecology. I also played a major role in curriculum development and was responsible for the accreditation of the first degree program in Coastal Zone Management.

The six year itch was up and time to move on, this time into the private sector. I joined Hollingsworth Consulting Engineers in Brisbane (which became Dames and Moore and is now part of URS), as their Senior Environmental consultant. There I rapidly learnt "never let inexperience prevent you from becoming the expert". My first job - off to Emerald (central Queensland) to do a flora and fauna survey and community consultation for a new coal mine. Alone (no mobile phones then) with a 4WD, hard hat, four litres of drinking water (more important than food), notebook and aerial photographs, I would be up from dawn to dusk scouring the mining lease, mapping the vegetation and looking for rare and threatened species.

I learnt so much in the following six years as a consultant, travelled to amazing remote places, entered the witness box on numerous occasions as an "expert", pumped out those Environmental Impact Assessments - tourist resorts, power stations, coal mines, marinas, sand mines, oil pipe lines … you name it. It was great. However I was ready to re-enter academia. Griffith University was starting its new Environmental Engineering degree and our Inaugural Professor - Philip Jones, advertised for "an ecologist to develop and teach ecological subjects of relevance to environmental engineers and, who had an understanding of current communication problems between engineers and ecologists". So here was my opportunity.

In March 1991 after my last official task with Dames and Moore (a two week field survey of the CRA Century Zinc Mine Site) I took up my position at Griffith University. My first challenge to create an awareness among our engineering students of their responsibilities to safeguard the environment, to recognise the need for balance between conserving biodiversity and economic development, and to direct them into finding environmentally sensitive solutions to improve the quality of air, land and water. My second challenge was to develop an area of research relevant to environmental engineering.

I continued initially with my seagrass work investigating the impacts of turbidity on seagrass depth distribution and productivity in Trinity Inlet, Cairns. At the same time I started to look at Melaleuca wetlands. One of my last consultancies with Dames and Moore was to assess the impact of a shopping centre complex on a Melaleuca forested wetland. It was obvious at times of flooding that this Melaleuca wetland would form part of a continuum linking downstream to mangrove wetlands and Moreton Bay. Was this Melaleuca wetland hydrologically important? Would it function as a sink or source of nutrients? There was nothing in the literature and this became my research question.

Then, in 1992 I attended the International Conference on Wetland Systems for Water Pollution Control in Sydney. This lead to my involvement in a collaborative research project with the Queensland Department of Natural Resources investigating the role of constructed wetlands in the treatment of municipal effluent. Guidelines based on this research have recently (September 2000) been published by the Queensland Department of Natural Resources.

My research on Melaleuca wetlands continued and led to the recognition of the importance of these forest systems for water storage and nutrient removal as well as many ecological values. These diminishing wetlands had to be preserved - I became involved with community education supported by grants from Environment Australia. The most recent grants from Coastcare involved the community (schools, scouts, wildlife groups, uni students) in monitoring water quality and aquatic biota in a tributary of the lower Logan River and revealed some disturbing facts about non-point pollution sources within the upper catchment. Fortunately the downstream Carbrook Wetlands, which are now preserved, are doing an excellent job in water purification. My research interests in wetlands and water quality continue and are being aptly applied to my involvement in Program 4 - Urban Stormwater Quality (see *Catchword* August 2000).

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WHERE ARE THEY NOW?

Report by Natasha Herron

As I write it is exactly one year to the day since I submitted my PhD thesis. For all who have forgotten, I investigated the role of valley fill deposits in modifying runoff delivery through catchments. In amongst the various tasks I do now at the Bureau of Rural Sciences (BRS) in Canberra, I still have the opportunity to ponder upon matters of hydrologic connectivity, in as much as it relates to issues of salt movement within catchments and catchment condition (Theme 7 of the National Land and Water Resources Audit).

I started with BRS as a geomorphologist-hydrologist in February this year. While I have yet to reveal my geomorphic talents, I have been fortunate to work with Richard Davis from CSIRO Land and Water on a water availability project, which allows me to be what I spent the last 4.5 years training to be - a hydrologist, or a modeller thereof.

The project I refer to was an investigation of the likely impacts on streamflow in the Macquarie River catchment for a range of tree replanting and global warming scenarios. We obtained the Integrated Quantity-Quality Model (IQQM) from the Department of Land and Water Conservation in NSW to generate and route streamflow and then set about modifying the tributary catchment input files to reflect different levels of tree replanting in the headwaters. Tree replanting scenarios were based on a forest capability map of the catchment, produced for us by the Forest Section of BRS using the 3-PG tree growth model (Waring and Landsberg, 1987). We looked at high, mid and low replanting scenarios, by themselves and in conjunction with various estimates of global warming. Roger Jones from CSIRO Atmospheric Research supplied us with climate files for the wettest, driest and a mid-range forecasts from a number of global climate models that he has been looking at.

Results from this work indicate that large-scale tree replantings could have a fairly major impact on water availability in the Macquarie. For a 10% increase in tree cover in the headwater area, a 25% reduction in streamflows was predicted. Lesser reductions were predicted for more modest tree replantings. The global warming impacts were found not to be as significant as the tree replantings modelled, with changes to Burrendong Dam inflows varying from the present by +1 and –16%.

The biggest influence on water availability in the Macquarie, however, is climate variability. Mean annual streamflow for the period 1890 to 1948 was significantly lower than for the 1949 to 1997 period, reflecting the generally drier climate regime during this time. It is our conclusion that inter-decadal climate shifts have a more dramatic effect on water availability in the Macquarie than either tree replanting or global warming impacts. We are now left to ponder the question of how to manage for a climate sequence which falls outside the range of climate conditions that we are accustomed to.

Following on from this initial assessment, I am now looking at the magnitude of streamflow reductions in the Macquarie should we start to strategically locate tree replantings in salt affected catchments. The mid-Macquarie catchments (particularly the Talbragar and Little Rivers) have been identified as contributing most of the salt to the Macquarie River. The question is whether we can reduce the delivery of salt from these tributaries through tree replanting without significantly reducing the quantity of water in the main channel, needed downstream for irrigators and environmental flows to the Macquarie Marshes. Early results look promising.

I am trying to get more irons into fires to ensure an interesting and productive time ahead. Perhaps you will hear more of me in a future edition.

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WANT TO KNOW WHAT'S GOING ON?

The CRC event calendar at www.catchment.crc.org.au allows you a 'sneak preview' of what is coming up month by month.

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