CSIRO LAND and WATER News
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Land & Water Link

Photo: Bill van Aken

Where Earth and Sky Meet

Drs Paul Reddell and David McJannet from CSIRO Land and Water may have their heads in the clouds, but their feet are certainly on the ground. They know that the wet tropics of North Queensland hold a secret – a secret that has the strange scientific name of occult precipitation.

Just as your skin collects droplets of water when you walk into a steam bath, so the trees collect water from the clouds as they roll through the rainforest.

In the highest parts of the wet tropics – particularly above 900 m – the trees 'strip' water from low-level clouds and fogs. This hidden water source is not measured by standard rain gauges, but early estimates put it as high as 30% of the total water flowing into high altitude sites.

Dr Reddell explains 'This is an important contribution to the water cycle, yet so far its role is poorly understood.' His research team aims to increase scientific understanding of the importance of cloud stripping in the water cycle of North Queensland. The two routes for cloud stripped water are 'throughfall' – water that falls directly through the canopy, and 'stemfall' – water that runs down the tree trunks.

To assess the importance of cloud stripping, the research team is not only relying on the standard open-air rain gauges at sites like Mt Lewis, but is also directly measuring the water that reaches the ground in the adjacent forest. The difference between the open-air gauges and the forest gauges will show exactly how much water is being stripped from the clouds.

One of David's sites is looking exclusively at cloud interception, where the rainforest strips moisture directly from the clouds. Not normally measured with conventional precipitation gauges, it appears that cloud stripping makes a significant contribution to the overall water balance of the rainforest ecosystem.

'The wet tropical mountain forests contribute so much to the water cycle,' adds Dr McJannet, 'because on top of gathering a lot of water from the clouds, they also use very little. They act like giant sponges, absorbing water, which they then release to the rest of the system through streams and rivers.'

The research will help develop gauges that can accurately estimate cloud stripping at a wide range of sites. It will also provide solid scientific information to policy makers concerned with sustainable water allocation policy.

Research outcomes will highlight the benefits of conserving the existing forests, and possibly encourage the replanting of marginal land in upland catchments. The resulting ecosystem service, in terms of increased water supply, is likely to be worth more than the returns on poor agricultural land. The work is funded by the CRC for Tropical Rainforest, Ecology and Management.

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Award Winning Sustainable Farming Research

Multiple awards have paid tribute to the great work being undertaken by Mallee Sustainable Farming Project, which was featured in the last issue of Land and Water Link. At the National Landcare Awards announced on 8 August, the project was named the winner of the BHP Billiton Landcare Research Award. The project has also received an award from the inaugural River Murray Catchment Water Management Board Environmental Awards under the category 'Changing Farming Practices', and was a finalist for the recent Banksia Awards (Community Groups).

This farmer-managed community group was formed to increase the adoption of sustainable and profitable farming practices in the four million hectares of low rainfall mallee of New South Wales, Victoria and South Australia. Groundwater recharge into the Murray River, wind erosion and productivity are the key issues being addressed.

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Photo: Rob Bramley

Harvesting a crop of Ruby Cabernet at Nangiloc, Sunraysia - Vintage 2001

Precision Practices Target Grapes and Wine

Yield mapping is an important component in a new suite of precision farming practices offering Australian grapegrowers a powerful new tool for sustainable production.

Working with growers in the Coonawarra, Clare Valley and Sunraysia districts, CSIRO Land and Water's Dr Rob Bramley is at the cutting edge of precision viticulture. He is engaged in the application and development of technologies to help growers understand vineyard variability and the factors causing it. In essence, he is helping growers understand what makes their vineyard tick, and how they can harness this understanding to improve yields.

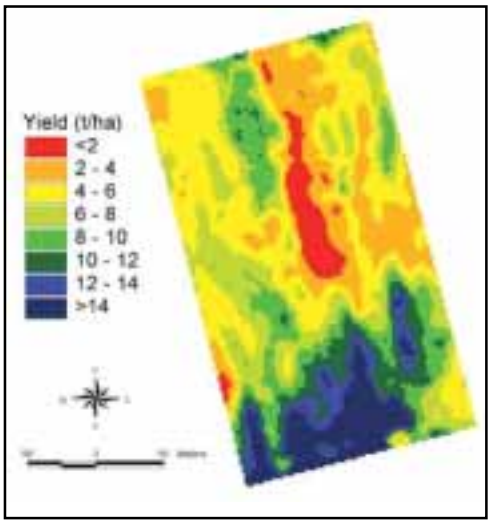
In projects conducted in conjunction with the Cooperative Research Centre for Viticulture and Southcorp Wines, he has been involved in trials using harvesters fitted with grape yield monitors over three consecutive vintages.

Dr Bramley says 'As grapegrowers become more sophisticated in their approach to vine establishment and management, they are using monitoring equipment to track vineyard performance rather than relying on gut feeling. They soon discover that their vineyards are highly variable in terms of both yield and quality.'

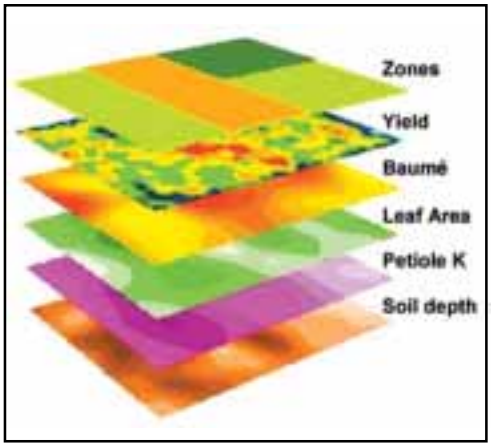
'For example, in Coonawarra and Clare, where we have been yield mapping with Southcorp Wines for more than two vintages, the range of yield variation is typically eight to ten fold. A number of indices of fruit quality and vine performance have also been shown to be highly variable, as have vineyard soils.'

An even wider range of monitoring equipment is expected to be available in the future, giving growers more detailed information about the nature of the variations.

Variation in yield of Cabernet Sauvignon (Vintage 2000) in a block in the Clare Valley



A major focus of the precision viticulture research is to identify the key drivers of variation in yield and fruit quality so that 'zones' meriting differential management can be identified



Graphics: Rob Bramley

The next step is to discover whether the pattern of vineyard variation is constant over time, in which case adoption of precision agriculture technologies could produce significant benefits. The research is also looking more closely at what is driving variation – for example soil properties – with a view to managing these factors.

'In our efforts to understand what is making the vineyard tick, we've sampled practically everything you can measure. We've overlain maps on top of maps – for example baume maps on yield maps and maps of soil properties. And while some attributes follow similar patterns of variation, others do not. We're trying to understand why that is.'

After the information is evaluated spatially using geographical information systems (GIS), growers and researchers can devise a tailored management plan for production of both grapes and wine.

Rob Bramley explains 'For example, we can section the vineyard into areas of differing quality and harvest these into separate bins. Growers may also be able to design their irrigation so that some parts of a block receive a different amount of water to others. They might vary their fertiliser or the way they prune for different parts of the vineyard. In short, it's all about targeted management.'

Yield maps have other applications and benefits. If growers can predict the potential volume of wine they will produce, they can schedule harvesting more accurately taking factors such as tank space into account.

'We have also produced maps of gross margins for grapegrowers with the aim of improving the performance of different area of vines', says Dr Bramley. 'It's surprising that under uniform management, quite large areas actually operate at a loss. It might be more appropriate to apply different management practices to these areas compared with the more profitable ones.'

Decisions as to the use and timing of many viticultural operations are dependent on accurate vineyard sampling. Some examples are the scheduling of harvesting and irrigation, and whether or not to use practices such as leaf plucking or crop thinning.

Crop forecasting and the payment of premiums for fruit meeting certain quality specifications also depend on ability to representatively sample vineyard perform-

ance. Growers seeking the best prices for their fruit want to be confident that it is being assessed in a robust manner and harvested under optimal conditions.

Because precision viticulture involves a continual cyclical process of information collection and use, it may be adopted incrementally and, assuming that the pattern of spatial variation remains constant from year to year, in time the maps become predictive.

'This means growers will eventually see which areas they want to harvest first,' says Dr Bramley 'because they know what the fruit quality will be like and what tonnage they are likely to pick. Over time, they'll develop a clearly defined picture of how their vineyard performs. They may well decide to harvest a block into several different bins, allowing them to parcel their fruit according to particular characteristics.'

Because vineyard variations take an unnecessary chunk out of grower returns, this work is of crucial importance. The cost of yield monitoring, based on the 1999 Australian average grape yield of 10t/ha and assuming costs are spread over 5 years, would be $3.80 per tonne.

According to Dr Bramley, even if the total cost of implementing precision viticulture increased to $5/t, it would still be only about 0.5% of the price received for the fruit. 'In other words, we are talking about the acquisition of some very cheap, but potentially very valuable information.'

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New Website for CSIRO Land and Water

CSIRO Land and Water has recently launched a new website with a fresh look, improved navigation options and lots of new content – www.clw.csiro.au

Added features include an Online Image Gallery, a whole section devoted to Education Resources, and a revamped Doing Business with Us area for commercial information and contacts.

Our new homepage features current media releases and events – allowing you to stay up to date with latest news from CSIRO Land and Water.

Perhaps the biggest change, though, is the creation of Current Issues sections. These 'gateways' to major land and water challenges like salinity include links to CSIRO's research involvement, collaborative projects, research partners, models and tools, key publications and contacts. The issues pages will be updated continually, and we will also be adding new issues to the collection.

We welcome your feedback.

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Healthy Australia

Photo: Bill van Aken

Australians are used to thinking big. We live in a continent of vast deserts, huge rocks and remarkable distances. Right now, we also have big problems. Many of these problems are attributable to old-world ways in agriculture, culture and business.

These ways may have served us in pioneering days, but they are not necessarily in harmony with the environment or with this century.

Salinity, acidity, sodicity, declining water quality, loss of biodiversity – the list of environmental issues facing Australia is growing.

According to the Chief of CSIRO Land and Water Dr Graham Harris, we can, broadly speaking, tackle these problems in one of three ways.

'We can collectively collapse into passive pessimism. We can be naive optimists and misapply the old Australian standby 'She'll be right, mate'. Or, we can start to think like our continent: big – VERY BIG.'

'System-wide problems require system-wide solutions', asserts Dr Harris. 'Our goals are nothing less than radical change in land use, restoration of our rivers, and protection of biodiversity.' This may sound like scientific hubris, but it is not.

'The humility that comes from a recognition of the failures and limitations of science is propelling us to broader visions of how the science of sustainability can work within the larger picture of the Australian community. We are very wary of creating more problems than we solve. By the same token, it would be false pride and poor ethics to abandon the hard scientific effort to find solutions.'

'Many people think the cost of achieving these goals is too high. In reality, what is too costly is failure to achieve these goals, for this will jeopardise Australia's potential wealth. Finding a suite of solutions to our biggest problems will open up many opportunities to enhance Australia's economic prosperity and cultural cooperation.'

'Take the up-and-coming bush tucker industry', says Graham Harris. 'Bush foods are a sustainable agriculture that is already providing real benefits for indigenous communities, as well as generating business opportunities.'

It is definitely not a case of one-solution-fits-all, however. Many decisions will be hard, and inevitably mistakes will be made. But to create a sustainable future for ourselves here, we have no choice but to develop a variety of approaches and a mix of different land uses more in harmony with the landscape and yet capable of maintaining farm incomes. 'Nobody underestimates the scale of this task, yet that is no reason not to continue', urges Harris.

'We already have many advantages because of the collaborative nature of our existing research community and knowledge base, and the cooperative nature of Australians. But this is a challenge to work with greater complexity, with the broader community, and at unprecedented scales. It also means we can make globalisation work for us and the world, by exporting our creative solutions – know-how and technologies – to common problems.'

His background as an ecologist has trained Dr Harris to think about complexity and interacting communities, but the challenge he is issuing to his colleagues and the wider Australian community will demand great skill, courage and imagination.

What's required is nothing less than the re-thinking of landscape and river function, and a focus on landscape renewal for the benefit of Australia's economic, social, environmental and cultural wealth.

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Salinity scene with saline stream, Quairading, Western Australia

Photo: Bill van Aken

Land and Water Images Now Available Online

Ever wondered where our fabulous photos come from? Ever wanted to know whether others can use them?

With the launch of our new website, CSIRO Land and Water has made public our online image gallery – www.clw.csiro.au/photo

While the CSIRO Land and Water photo collection has long been well known and in demand, relatively few of our images (and we have more than 80,000 transparencies alone) have been publicly accessible.

Early in 2000, this prompted us to set about scanning and digitising key images from the collection. The online image gallery now boasts more than 1000 images and will grow steadily as more photos and categories are added. We also plan to add an online ordering facility and other features.

This service has been created to raise awareness of land and water issues in Australia.

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Fishing for the Right Balance to Algal Blooms

Introducing predatory fish to water reservoirs can be an environmentally-friendly method of controlling outbreaks of toxic blue-green algae. But as researchers in CSIRO Land and Water have discovered, they have to be the right fish in the right place at the right time – or else they might just end up making the problem worse.

Dr Vladimir Matveev and his team have been working towards a theory for predicting just the right balance of fish stocking in reservoirs to cope with algal blooms.

For some time it was believed that stocking a reservoir with large predatory fish would reduce the numbers of small fish, and that this in turn would increase numbers of certain water fleas (*Daphnia*) on which the small fish habitually feed. *Daphnia* and other small water creatures are micro-grazers, feeding on algae. The idea is to help control toxic algae by increasing the number of micro-grazers.

In a first for Australia, Dr Matveev and his team are testing the consequences of fish stocking water storages at the ecosystem level, taking into account the complex interactions between micro-algae, micro-grazers and small fish.

Vladimir explains 'In Australia, predatory fish are stocked as juveniles for angling purposes. It is less expensive to buy the smaller of these juvenile fish for stocking, without considering the effect on the ecosystem.'

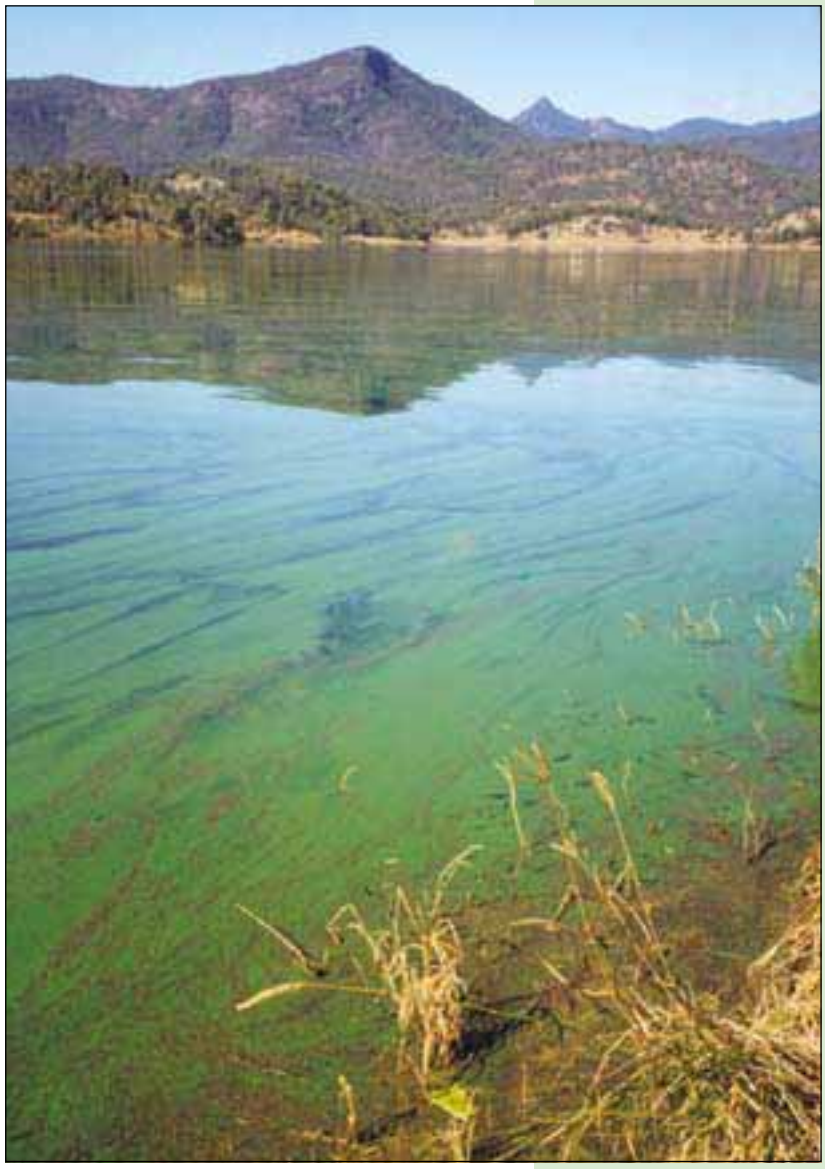

Photo: Vladimir Matveev

Blue-green algae on Lake Maroon, southeast Queensland (one of the experimental lakes used in the project)

When concerned water storage managers in Queensland asked Vladimir to comment on the risks associated with this practice, he turned to experimental results from the USA which showed that adding high numbers of small fish to experimental systems caused continuous algal blooms under some conditions.

'Theoretically, we predict that if the smaller juvenile predatory fish are overstocked, these fish will stop growing', says Dr Matveev. 'Instead of controlling numbers of other small fish and reducing algal abundance, they may feed on the water fleas themselves. In a worst case scenario, they might double the existing pressures on the micro-grazers and increase re-

cycling supply of nutrients to the algae – and actually cause more algal blooms.

'We need to develop a theory to quantitatively predict the threshold for fish stocking, below which the effects are favourable for reservoir ecosystem health, and above which the effects become adverse,' adds Vladimir. 'As is always the case with ecology, it is an issue of proper balance.'

The project is a joint venture of the National Eutrophication Management Program established by Land and Water Australia and the Murray-Darling Basin Commission, and involves as partners Queensland Department of Natural Resources, SunWater, University of Queensland, Queensland University of Technology, and the Maroon-Moogerah Fish Stocking Association.

Vlad Matveev on Lake Maroon

Photo: Andrew Palmer

***Daphnia carinata*: one of the micro-munchers that feeds on algae**

Photo: Lilian Matveeva

The researchers are using a high-tech hydro-acoustic system to monitor small fish numbers and the responses of micro-grazers and algae in an experimental lake and a reference lake in southeast Queensland. The study, which has been underway since 1997, involved stocking the reservoir with 100,000 Australian bass in 1999. To find out whether the bass are successful algae controls, the team will have to wait until August 2002.

'The unique whole-of-ecosystem approach that we are taking means we have to work on an ecosystem timescale. At least five years of observation is necessary', explains Vladimir.

The CSIRO team believes that the long wait will be worthwhile in terms of ongoing benefits to Australia. 'Our planned outcome is to produce an effective tool for biological control of nuisance micro-algae', says Vladimir. 'We hope to produce a conceptual model of lake and reservoir ecosystem functioning, which provides water storage managers with recommendations for optimal fish stocking strategies and methods to minimise ecological risks in dam management.'

In the future, this project may involve new areas of research including the assessment of all possible ecological risks for dam management. In the meantime, the hungry fish in southeast Queensland continue to munch, unaware that they could be doing Australia's waterways – and themselves – a big favour.

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Photo: Bill van Aken

Flooded rice bays, Griffith, New South Wales

Groundwater Research Aids Irrigators

Groundwater research and new hydrologic economic tools are helping change the way irrigators and regulators approach irrigation in southern NSW.

Developed by a CSIRO Land and Water research team based in Griffith, the models are used in tandem with research outcomes that demonstrate the importance of groundwater movement in irrigation, drainage and salinity management.

By using crop, water and soil data and detailed hydrogeological and economic analysis, the research team has built on its well-known SWAGMAN (Salt, WAter and Groundwater MANagement) series of soil and groundwater models.

Researchers were also able to draw upon valuable rainfall data contained in 100-year Standard Precipitation Indices as a basis for detecting minor variations from average rainfall, and its impact on the water table in irrigation areas.

As a result, new regional surface-groundwater interaction models have been developed in the Murrumbidgee, Coleambally and Murray Valley.

According to CSIRO team leader Dr Shahbaz Khan, irrigators and irrigation companies through the southern NSW irrigation regions were taking on board the latest research.

'We are finding that as CSIRO's modelling tools are being taken

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up, they are changing the mindset of irrigators, regulators and environmental managers', says Dr Khan.

Research findings have centred on the role of regional groundwater movement, showing how this contributes to problems like the rising watertable and soil salinisation.

'We have found that over-irrigation and the ponded conditions needed to grow rice leaches pre-irrigation salts from soil profiles and adds to groundwater salinity.'

Dr Khan explains, 'Where the watertables are shallow, salts start accumulating in the root zone through capillary upflow as there is not enough room to leach out these salts. We also found that shallow watertables meant even minor deviations from average rainfall could lead to a big rise in watertable levels.'

Knowing more about local and regional movement of groundwater and salts would help address problems such as rising salinity levels in aquifers, deteriorating water quality in drains and high rice water use, says Shahbaz Khan.

'We are learning how inefficient farm practices contribute to a rise in the watertable under a farm and also impact on the watertables under other farms connected to the same aquifer.'

Adopting the research recommendations, the Coleambally Irrigation Area has divided its Land and Water Management Plan into five regions based on the regional groundwater flow patterns uncovered by the CSIRO groundwater investigation.

Another practical application involves a group of farmers located just west of the Coleambally Irrigation Area. This group has initiated a Natural Heritage Trust funded revegetation project, combining their local knowledge with the CSIRO groundwater research.

CSIRO Land and Water's Shahbaz Khan and Jason Carroll are working with Greening Australia representatives to help the group plan the best place for revegetation activity.

The CSIRO Land and Water research team also includes Natalie O'Connell, Louisa Best, Butian Wang and Zhou Wang. The research has been funded by a range of partners including the Co-operative Research Centre for Sustainable Rice Production (Rice CRC), Murray Irrigation Limited, Murrumbidgee Irrigation Limited, Coleambally Irrigation Cooperative Limited, and local farmers through the Natural Heritage Trust.

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