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Land & Water Link

Photo: Bill van Aken

The Big Dry

Australia's south-west has been dry for 27 years and the lengthy drought could be a foretaste of future experiences across southern parts of the nation due to the enhanced greenhouse effect.

CSIRO scientists are investigating the possibility that a climate shift has brought a long-term decline in rainfall over southwest Western Australia.

'Measurements indicate a slow decline in rainfall since the 1940s to the 1950s, leading to the present drier regime', says Dr Bryson Bates of CSIRO Land and Water.

In some parts of the south-western region, average rainfall appears to have settled into a pattern about 20 per cent lower than the norm for the first half of the 20th century – but, as the thirsty landscape soaks up more moisture, this has led to a 40 per cent reduction in inflow to Perth's dams. At the start of summer, the dams are less than a third of capacity.

The immediate cause, says Dr Bates, is a clearly discernible climate shift that took place in the mid 1970s.

'At that time the tropical Pacific warmed abruptly and stayed warm, and there was a sudden warming in sea surface temperatures in the Indian Ocean. Since then there have been unusually frequent, persistent and intense El Ninos, and fewer La Ninas.'

Working from global atmospheric data, the researchers have been trying to work out what this all means for local climate and rainfall across the southern part of Western Australia.

The most obvious fact to emerge is that there are now more dry days than before due to an increase in the presence of high-

pressure cells to southeast of the region, causing moisture-bearing air streams to miss the continent. The encouraging news is that the system appears to have stabilised somewhat, although there is a large amount of year-to-year variability.

The main change lies in the absence of particularly wet winters, which once recharged the dams. Since 1975 there has been only one winter of above-average inflow to the dams, compared with 13 in the period from 1950 to 1975.

As to what is 'forcing' the new climate pattern, the team is exploring apparent links with changes in the behaviour of El Nino and the Antarctic Oscillation Index. Prior to the 1970s, when times were wetter, this index was negative. However, since the mid-1970s it has swung into the positive, with zones of higher than usual air pressure forming over the southern Indian and Pacific oceans.

Dr Bates says that present indications are that such a prolonged dry spell is fairly rare, and that it is likely to be due to the earth's natural climatic fluctuations, rather than man-made changes to the atmosphere.

'However, the present experience matches what climate projections are indicating may happen over the next hundred years. So the experience of south-western WA may foreshadow the sorts of impacts we will start to see in southern Australia under greenhouse-induced climate change.'

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Global Spotlight on the Murrumbidgee

Cooperation between researchers, farmers and industry in the Lower Murrumbidgee catchment – and its power to achieve useful and practical on-ground results – has won global recognition. The southern NSW catchment has been named as the UNESCO HELP program's first global reference basin. This means that the region's farmers, researchers and irrigation companies will be used as an example to the world, to showcase practical solutions for water resources management under competing water uses and economic concerns.

UNESCO's HELP (Hydrology, Environment, Life and Policy) program seeks examples of good solutions-oriented science, which are delivering real outcomes to real people in real catchments, both locally and globally.

HELP's interest in the Murrumbidgee catchment arises from work by CSIRO Land and Water and its partners, including the CRC Sustainable Rice Production, Coleambally Irrigation Cooperative, Coleambally Outfall District Water Users Association and Murrumbidgee Irrigation. Their research efforts are addressing problems including rising watertables and salinity, reduced river flows, legislative reforms, competition between water users including the environment, and falling deep aquifer pressure levels.

The catchment is significant, with 2730 farms spread over 560,000 hectares in the Murrumbidgee and Coleambally irrigation areas. Almost a quarter of the water extracted

Photos: Greg Heath

Aerial view of Murrumbidgee catchment. Dr Shahbaz Khan (inset).

from the Murray-Darling Basin each year is used in the region to produce more than $1 billion worth of crops – almost 16 per cent of Australia's agricultural produce. There are more than 10,000 kilometres of irrigated channels and the region's combined irrigated agriculture is worth about $408 million.

A critical factor underpinning the catchment's new status was the way people put research into practice on the ground, using modeling tools such as the SWAGMAN hydrologic, economic and community education models developed by CSIRO Land and Water.

According to CSIRO Land and Water scientist Dr Shahbaz Khan, 'The Lower Murrumbidgee catchment presents an excellent example of community involvement in hydrological research and the development of integrated catchment management policies using a range of tools. Hydrological projects involved communities, researchers and regulatory bodies in catchment management as GIS, hydrological, economic and educational models were developed.'

Dr Khan explains, 'Science is required to manage the water resource, but it needs to look not just at the water but also at the economic, policy and legal aspects. There are regions in the world where this is done in bits and pieces, but here in the Murrumbidgee we have managed to pull it all together.'

Modeling tools and participatory hydrologic research methods used in the Murrumbidgee catchment are also being adopted by communities in Liuyuankou irrigation area along the Yellow River in China and Rechna Doab in the Indus basin through projects supported by the Australian Centre for International Agricultural Research (ACIAR). There is also considerable interest in applying these tools in catchments in India and South Africa.

CSIRO Land and Water has created a website to provide information on the project: www.clw.csiro.au/research/agriculture/irrigated/help/

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Linking Agriculture, Environment and Economy

Around the world, agricultural and rural industries are seizing the initiative to adopt voluntary (non-legislated) approaches to environmental management, as well as to quality assurance, food safety and animal welfare. As uptake of these voluntary environmental management arrangements (VEMAs) gathers momentum, there are implications for the future of Australian agricultural and rural industries.

To help shape Australian participation in this area, a joint project funded by Rural Industries Research and Development Corporation (RIRDC) and CSIRO has provided a report that allows stakeholders to assess the design features, implications and merits of various models – *VEMAs: Designing voluntary environmental management arrangements to improve natural resource management in agriculture and allied rural industries*.

Dr Thea Mech, resource economist and co-author, explains the significance of VEMAs and their potential promise for addressing complex environmental and natural resource management (NRM) issues in agriculture.

'VEMAs are indicative of the paradigm shift in how NRM and environmental protection are being thought about and approached. What we are seeing is a search for new management tools and policy instruments that represent a departure from orthodox government programs and regulation. The new agenda stresses industry's potential to develop its own solutions.'

'VEMA' is an umbrella term embracing many very different types of arrangements including environmental management systems, as well as various production protocols that may be part of environmental certification schemes and environmental labeling initiatives.

Dr Mech explains, 'As their name implies, all VEMAs share two common features: they are concerned with environmental management, and they are undertaken voluntarily. While VEMAs are 'voluntary' in the sense that participation in them is not prescribed by law, it is critical for the Australian agricultural industry to realise that their uptake including verifiable compliance against specific standards may increasingly become a precondition of entry to some trade markets.'

Ultimately, the success of VEMAs depends upon how industry and business embraces them. To ensure the environmental and commercial sustainability of agricultural and rural industries, perhaps the most important tasks and challenges ahead involve identifying the nature of the optimum mix of voluntary and formal approaches to environmental management, and creating an enabling environment for industry and business to participate.

Dr Mech cautions, 'Although VEMAs hold enormous promise as a possible means of addressing complex environmental and NRM issues, it would be premature to view VEMAs as an environmental management panacea. An optimum mix of

Photo: John Coppi

formal government and voluntary industry and community-led approaches is likely to result in the best environmental, marketplace and social outcomes.'

The CSIRO Land and Water project team is now working on five RIRDC Briefing Papers, each addressing different aspects of improving environmental management in agriculture through voluntary means. Greater understanding of four interconnected areas is needed to link demonstrable environmental improvement with marketplace benefits.

These areas cover the design of environmental standards and guidelines for agriculture and rural industries, their incorporation into credible and feasible environmental labeling and certification schemes, the greening of agri-food supply chains, and the growing importance of 'the environment' in emerging international trade policy with consequent implications for Australian agriculture.

The CSIRO team is also exploring the relationships, synergies and tensions between voluntary, regulatory and market-based approaches to environmental management.

The report on VEMAs, written by Thea Mech and Mike Young, is available on the RIRDC website: www.rirdc.gov.au/reports/Ras/CSL-15A.pdf

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'An optimum mix of formal government and voluntary industry and community-led approaches is likely to result in the best environmental, marketplace and social outcomes.'

True-colour satellite image created by NASA shows fire hotspots and smoke plumes in southern NSW on 3 January 2002. (Image created from MODIS data)

Disasters – Seeing the Big Picture

Last Christmas as the first of the bushfires roared through forests and destroyed homes in New South Wales, CSIRO researchers worked quickly to show a bigger and better picture of the disaster as it unfolded.

They created highly detailed satellite images of the fires that burnt beneath the smoke plumes up and down the coast of New South Wales. While emergency services and the media focused on the fires in that State, the scientists could also see large fires burning in Western Australia and the Northern Territory.

Alex Held and Alan Marks of the Environmental Remote Sensing Group at CSIRO Land and Water in Canberra created fire maps using data from a US-owned satellite. It was launched into space in late 1999 by the National Aeronautics and Space Administration (NASA) and carries an advanced sensor called a Moderate Resolution Imaging Spectrometer (MODIS).

The CSIRO Land and Water group works with other CSIRO researchers to develop new ways of using MODIS data for a variety of applications including the monitoring of coastal water quality and crop conditions. The Christmas fires however, became a test run for how quickly this data could be downloaded by receiving stations operated by the Australian Centre for Remote Sensing (ACRES) and delivered to emergency services.

MODIS orbits earth and records reflected light (colour and intensity) from everywhere around the world every 1–2 days. The data it generates has a combination of features that makes it particularly useful for tracking large-scale disasters in Australia. For example, nearly every day MODIS takes snapshots of the same places in Australia as it passes overhead and each snapshot covers a very large area.

From 700 kilometres above the earth it can 'zoom in' on an area as small as 250 m x 250 m and record the reflected 'colours' in 36 wavelengths, including the surface temperature. So even when smoke or clouds obscured the fires burning in NSW, MODIS still detected many of the hotspots because it could pick up heat differences. The greater sensitivity of the MODIS sensor is also expected to provide fire maps that are better at showing smaller and cooler fires, compared to those produced from more traditional satellite data.

Alex Held and his team used the MODIS data to track the fire fronts day-by-day through December and January, and emailed fire maps to relevant agencies. 'The images spoke a thousand words – they gave a clear and detailed overview of the whole situation in New South Wales', he says.

'We demonstrated that the MODIS sensor, combined with other satellite sensors used by colleagues in CSIRO and the Department of Land Administration in WA, can provide almost real-time fire monitoring from space.'

'It is clear that maps derived from such satellite data could be equally useful if other large-scale disasters like floods, cyclones and coastal oil spills hit Australia', predicts Alex Held.

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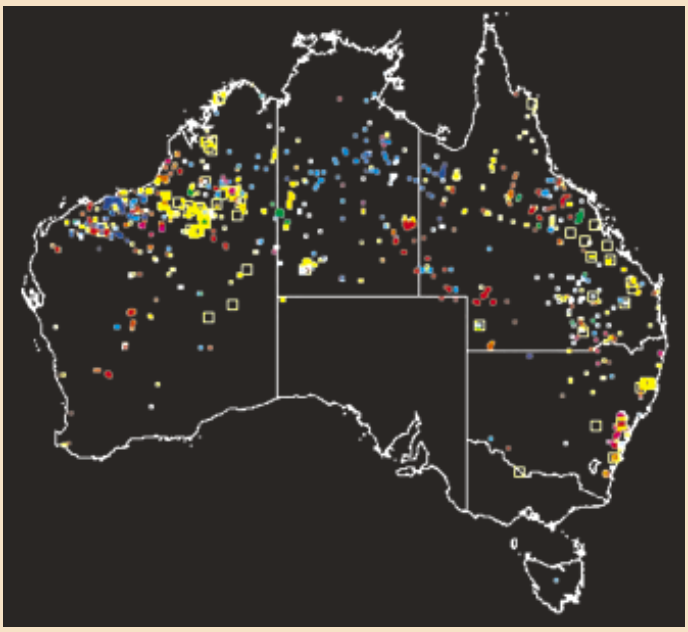

Active fires or fire hotspots across Australia 1–24 January 2002. The hotspots are shown in a different colour for each day. (Image created from MODIS data)

Photo: Bill van Aken

Salinity scene with saline stream near Quairading, WA

Trees to Combat Salinity

A comprehensive new guide to using farm forestry to combat salinity is set to improve tree-planting outcomes.

Dryland salinity is one of Australia's biggest, long-term land degradation problems. Yet it has only entered the collective consciousness of Australians in the past ten years. The realisation that tree clearing contributes to dryland salinity has fueled an ongoing debate about how many trees, if any, should be replanted in an attempt to halt the problem.

For those who look to tree planting as a solution, the critical questions have been how many trees, and where to plant them. To shed light on these complex issues, hydrologists, plant physiologists and foresters from CSIRO and other agencies, joined forces under the Joint Venture Agroforestry Program. The result is a landmark publication: *Trees, water and salt: An Australian guide to using trees for healthy catchments and productive farms*.

Launched in March this year, the book describes hydrology concepts and practical tree planting options to reduce salinity at the catchment scale. Advice is offered on how to locate trees in the most effective place for salinity control and at the same time, achieve the best growth.

Five scenarios are discussed. These involve tree planting:

- in high recharge areas such as sandy or shallow soils
- in blocks for wood production in rotation with agriculture
- in belts on hillslopes
- in belts mixed in with agriculture
- over shallow, saline watertables.

According to CSIRO Land and Water researcher Dr Richard Stirzaker (co-editor), 'We describe the theory behind each option to help people decide for themselves what part of the catchment and in what arrangement – alleys, belts or blocks – to plant trees as part of a broader strategy. And we discuss the chances of success for each option in different catchment situations.'

Reflecting on the salinity debate, Dr Stirzaker says 'Many of the early warnings and initial predictions about the extent of looming salinity problems came from the hydrologists – those tracking the amounts and fate of water. They rightly said we weren't doing enough to fix the problem and tried to predict the area of agricultural land that we would need to plant with trees to halt salinity. Popular opinion in the early 1990s put it at 10%, and to many that seemed achievable.

'But by 1997, hydrologists were talking about the need to plant 70% to trees in many catchments. This would mean a total change in the way the land was used and it would take decades to know if the tree plantings worked. Hence, many began to question whether trees could provide an answer.'

Dr Stirzaker adds, 'The debate continues to be vigorous and proposed alternatives to tree planting, such as engineering solutions, are also yet to be proved. However, as we become more adept at identifying those catchments where we should focus our efforts, *Trees water and salt* offers a practical guide to the most effective tree-planting strategies.'

Trees, water and salt links the knowledge and long-term predictions of the hydrologists with the knowledge and needs of farmers. 'These are two very different disciplines and two very different ways of thinking. I'm proud of the fact that this book looks at the catchment reality – the cumulative and long-term effects of what we do, alongside the paddock-scale necessity – the need for annual productivity and returns', says Dr Stirzaker.

'If trees are part of the solution to salinity, and I think they are, then this book will be of value to farmers, extension officers and catchment management authorities.'

Trees, water and salt: An Australian guide to using trees for healthy catchments and productive farms edited by R. Stirzaker, R. Vertessy and A. Sarre, (RIRDC Publication No 01/086) is available from RIRDC, either as a full print version or as a summary online refer: www.rirdc.gov.au/reports/AFT/01-086.pdf

Photo: Bill van Aken

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Working Towards Sustainable Soils

What is the role of soil biota in sustainable soil function?

Dr Steve Rogers from CSIRO Land and Water and Dr Matt Colloff from CSIRO Entomology are developing molecular diagnostic tools to determine condition of soil biological activity so that we can assess the impacts of land management on ecosystem function.

Sustainable use of soils is being held back worldwide by the lack of a simple test that can tell farmers and other managers whether the land in their care is improving or getting worse. According to Steve Rogers and Matt Colloff, the answer lies in the soil – or at least in the billions of micro-organisms and natural chemical processes that control how the soil functions, and whether it becomes richer or poorer.

What's been missing until now is the ability to look at the 'big picture' – to see how these billions of different microbes combine to unlock the nutrients and elements vital to plant life and fertility, and how well they withstand shocks caused by human intervention or mismanagement.

'We know what's in the soil – we just don't know precisely what it does, how all these creatures interact, exactly how they combine to recycle nutrients and energy within the soil, in the form of carbon, nitrogen, phosphorus and sulphur and make them available to growing plants', Dr Colloff explains.

The solution was to look not at the microbes themselves, but at something far more basic – at the genes within the microbes that yield the natural chemicals that unlock soil nutrients.

Taking what resembles a 'public health' as opposed to 'individual patient' approach to soils, Steve Rogers and Matt Colloff are using off-the-shelf testing technologies to reveal the amount and diversity of key genes in micro-organisms in a soil responsible for nutrient cycling, and how active they are.

The result, they hope, will be a suite of tests to analyse a landscape and tell whether it is improving, stable or degrading. For the first time, this should give farmers and other land managers a realistic measure of whether their management tactics are making the situation better or worse, at least so far as biological function is concerned.

The team is using three trial sites across Australia – cane country and rainforest at Tully in Queensland, grazing land and *Banksia* scrub at Moora in Western Australia, and cropping country and native woodland in Victoria – to assess whether their genetic tests can provide consistent answers across a range of environments and management systems.

The team expects that it will take about three years to demonstrate whether reliable soil gene tests can provide a practical test of soil health under a wide range of conditions.

Photo: John Coppi

Such a test would have wide-spread application. A mining company wishing to know whether its land rehabilitation program is really working or not, could find part of the answer by looking at changes in soil function. It could be used by a national park, state forest body or a tourism manager to preserve natural ecosystems in the peak of condition.

Farmers, clearly, would find this approach invaluable as they experiment with more sustainable cropping and grazing systems, or compare one paddock's performance with another. It could even be used in cities to monitor the environmental health of parks, public gardens and reserves.

With growing international trade pressure for producers of all sorts of products to demonstrate that their production processes are sustainable, the use of an effective test could give Australia a global trading advantage.

Photo: Bill van Aken

This research is supported by Land and Water Australia.
Dr John Curran, Deputy Chief of CSIRO Entomology (one of the partners in this work) is part of the C-Quentec PCC/CSIRO/ Aventis/ SARDI Joint Venture Diagnostic Testing service.

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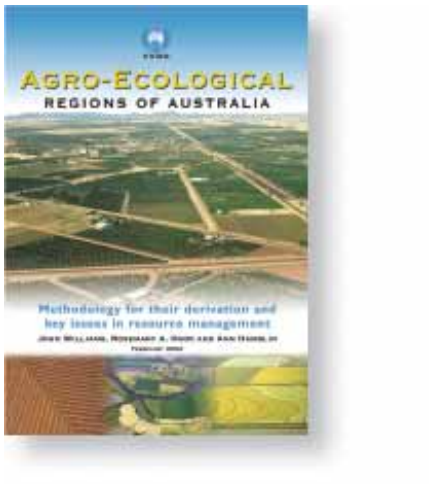
Australian Land Use Defined

Australia is a continent of changes. Wherever you travel in Australia, you will see different landforms and land uses, notice different geology – even experience vastly different climates. The way we use the land has developed over time and is influenced by its intrinsic productivity.

To understand the ecology and productivity of Australia's natural resources, it is helpful to define and identify different regions. A new book released by CSIRO Land and Water sets out a simple but sound description of Australia's major ecological regions together with the agricultural systems associated with them, linking population data to biophysical data for the first time.'

Agro-ecological regions of Australia: Methodologies for their derivation and key issues in resource management provides natural resource managers and agriculturalists with a straightforward identification of regions with common features such as soils, landscape features, climate, vegetation and agricultural land use. Dr John Williams, one of the authors of the book and Chief of CSIRO Land and Water, says that the regions are based on original definitions that were proposed



in 1991 by himself and fellow authors Anne Hamblin and Rosemary Hook.

'The book *Agro-ecological regions of Australia* lays down not only the regions themselves, but also describes the history of how and why these definitions were proposed', says Dr Williams. 'The aerial units are also based on local government boundaries – linking population data to biophysical data for the first time.'

'The sustainability of agriculture in Australia is linked to population as much as it is to climate and land features. Data collected on a census basis that uses these boundaries can also be used when mapping ecological and agricultural regions.'

Agro-ecological regions of Australia is available on the CSIRO Land and Water website: www.clw.csiro.au/publications/

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