

Will climate variability change in the future?



Mary Voice (Bureau of Meteorology), **Kay Abel** (Australian Greenhouse Office) and **Kevin Hennessey** at the Albury conference (see page 7 story)

A warmer world means increased moisture stress and drought for much of the continent. Likely changes pose an adaptation challenge according to CSIRO researcher Dr Kevin Hennessey.

Using results from nine climate models, CSIRO has produced a brochure on future changes in Australian temperature, rainfall and evaporation. (Visit www.dar.csiro.au/publications/projections2001.pdf).

During the 20th century, the Earth warmed by about 0.6°C. Most of the warming observed over the last 50 years is attributable to human influences. Greenhouse gas levels in the atmosphere have increased over the past 200 years due to human activities.

Australia warmed by 0.7°C from 1910-1999, with most of this increase occurring after 1950. Minima generally increased more than maxima. While there has been little change in continental-average rainfall since 1910, there have been significant regional trends.

Annual total rainfall has risen by about 15% in New South Wales, South Australia, Victoria and the Northern Territory. South-west

Western Australia has become 25% drier in winter. The heaviest 24-hour rainfall amount in a given season has increased in intensity by 20-30% in New South Wales in autumn and summer, in the Northern Territory in autumn, and in Western Australia in summer.

The Intergovernmental Panel on Climate Change (IPCC) states that continued increases in greenhouse gas levels will lead to a global warming of 1.4 to 5.8°C by the year 2100, relative to 1990. Climate change will not be globally uniform – what does this mean for Australia?

Future changes in Australia

By 2030, the warming relative to 1990 is 0.4 to 2°C over most of Australia, with slightly less warming in some coastal areas and Tasmania, and slightly more warming in the north-west. By 2070, annual average temperatures will increase by 1 to 6°C over most of Australia with exceptions similar to those for 2030. Greatest warming occurs in spring and least in winter.

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The Climate Variability in Agriculture R&D Program was initiated and is mainly funded by AFFA. Land & Water Australia administers the program which is also jointly supported by the following organisations

CVAP Review underway

The direction of future research will be determined by the CVAP review which is now under way, according to CVAP chair Mike Logan.

While announcing that Hassall & Associates has been commissioned to review

CVAP, Mike said that the review will concentrate on two components:

- 1) Scoping possible future directions for a Climate Variability Program. This will include considering links to other programs and initiatives, with stakeholder consultations in April and May; and
- 2) Reviewing the outputs and outcomes of the program,

which will mainly occur after June when remaining projects are completed. An evaluation workshop is scheduled for November.

The CVAP review team can be contacted at Hassall & Associates Pty Ltd, on phone (02) 9241 5655, fax (02) 9241 5684, or email: <vmanson@hassyd.aust.com>.

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Temperature extremes

While changes in temperature variability are negligible, increases in average temperature will affect the frequency of extreme events. For example, the average number of days over 35°C each summer in Perth would rise from 15 at present to 16-22 by 2030 and 18-39 by 2070.

Conversely, the average number of winter days below 0°C in Orange would drop from 38 at present to 18-32 by 2030 and 1-27 by 2070.

Annual rainfall

Changes are biased toward decrease in the south-west, and in parts of the south-east and Queensland.

Most other locations have an even chance of wetter or drier conditions. Decreases are most pronounced in winter and spring.

Some inland and eastern coastal areas become wetter in summer, and some inland areas become wetter in autumn.

These projections include the effect of simulated changes in El Niño and La Niña events.

Seasonal rainfall variability

Changes are small, but significant changes in average rainfall affect the frequency of extremes.

Where average rainfall increases, there are more flood years, and where average rainfall decreases there are more droughts.

Daily rainfall

Where average rainfall increases (or decreases

slightly), most models simulate an increase in extreme daily rainfall.

This represents an increase in daily rainfall variability. In regions where average rainfall decreases substantially, extreme rainfall events decline, so variability is reduced.

Available moisture

Warmer conditions will lead to increased evaporation. When this is combined with the simulated changes in rainfall, most locations show a decrease in available moisture.

This is likely to increase moisture stress and drought. Such changes pose an adaptation challenge for natural ecosystems, energy suppliers, water resource managers and farmers.



For further information, contact Dr Peter Whetton at CSIRO Atmospheric Research on phone: (03) 9239 4535, or email: <peter.whetton@dar.csiro.au>.

About CLIMAG

Climag, as the newsletter of the Climate Variability in Agriculture R&D Program (CVAP), has an important role in promoting the overall goal of the program:

"To work with the Australian agricultural sector to develop and implement profitable and sustainable management strategies which prepare it to respond to the major opportunities and risks arising from climate variability."

CVAP is a Commonwealth Government funded R&D program, and part of *Agriculture - Advancing Australia*. The major stakeholder is Agriculture, Fisheries and Forestry - Australia (AFFA). The program is administered and supported by the Land & Water Australia.

Four other R&D Corporations (see page 1) also currently support CVAP through funding for generic projects and for partnership funding of projects of value to their specific industry or charter.

For further information on CVAP go to the CVAP website at <www.cvap.gov.au>.

Dancing in the rain - farmers and agricultural scientists in a variable climate

Guest Spot

By Dr Peter Hayman

After finishing a Masters degree in crop physiology (drip irrigated tomato plants), I was appointed by NSW Agriculture as a district adviser to irrigated wheat growers in southern NSW.

A number of farmers pointed out that as useful as I might think a working knowledge of the Penman-Monteith equation was for their irrigation decisions, they had other problems when deciding when to irrigate.

Problems such as whether it might rain in the next week, whether a wind might blow the flood irrigated crop over and how they would juggle all the conflicting priorities on their farm.

By the time I embarked on my PhD studies I had 10 years experience as an advisory officer and had learnt a bit more about listening to farmers. The aims of the PhD study were to describe how farmers were currently managing climate variability and to use this knowledge for better design of decision support systems.

Interviews with over 90 farmers and 20 advisers in northern NSW provided information on their subjective risk assessment of seasonal rainfall and derivatives of

rainfall such as fallow recharge and crop yields.

When these subjective risk assessments were compared to the long-term rainfall record and simulated yields and fallow recharge, broad differences emerged. In most cases farmers saw the climate as:

- drier and more risky than the long-term record would suggest; and
- they rated the chance of crop failure and low yields, much higher than the simulated results.

These differences are interesting because conventional wisdom holds that agriculturalists are overly optimistic and need the long-term rainfall record to realise the true risks of farming in this wide, brown, dry land.

Furthermore, most of the farmers I interviewed had lived through a wetting trend. A farmer with perfect memory of the last 20 or 30 years would view the climate as wetter than the 100 year record suggested.

'It may be better to be roughly right with the farmers' rule of thumb, than precisely wrong with a scientific model'

Conventional wisdom holds that farmers would have overestimated the mean and underestimated the variability or spread of the distribution.

But the farmers I worked with saw the climate as riskier and



Photo by NSW Agriculture

drier than the long term records show.

A more important question is whether the differences between the risk assessment of farmers and that provided by science lead to different decisions. In the two case studies examined (Nitrogen rates in northern NSW and cropping frequency on the Liverpool Plains in northern NSW) the optimum decision tended to be relatively insensitive to the exact specification of the probability distribution of crop yield, the main reason for this was the flat response surface over a considerable range.

Even if a farmer could be persuaded to believe the modelled distribution of wheat yields, it may not lead to a change in the optimum action- which is to sow wheat and apply a good rate of fertiliser.

True, science can suggest a precise level of fertiliser, but to get this right we need to know a lot about the farmers' soil type and the amount of water stored in the soil.

It may be better to be roughly right with the farmers' rule of thumb than precisely wrong with a scientific model. In any case because the response

Dr Peter Hayman as a young researcher in the early nineties was one of the pioneers in applying seasonal rainfall forecasts to practical farming problems. Since then he has gained prominence in communicating the essentials of risk management using the chocolate wheel. He was an inaugural winner of a GRDC research communicator award. Peter is the leader of the NSW Agriculture's climate applications unit at Tamworth.

His recently awarded Doctor of Philosophy from University of Western Sydney had its origins in one of the first major projects by CVAP's predecessor. That project 'Decision support for climatic risk management in dryland crop production' was also funded by GRDC and RIRDC. The national network of researchers in the grain industry set up then still operates on an informal basis. Supervisors for the Ph D were Dr Samsul Huda and Prof Peter Cornish, UWS, Hawkesbury; Dr Brian Keating, CSIRO/APSRU; and Dr Peter Cox, ex CSIRO/APSRU. (Ed.)

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Survey shows forecasts use up

Three out of four Australian farmers are now aware of seasonal forecasts. For some industries such as sugar and cotton, about two thirds of all farmers are not only aware of the forecasts - they take them into account in management decisions on the farm.

The findings are from a comprehensive survey of over 2500 farmers, undertaken as part of the evaluation of the *Agriculture - Advancing Australia (AAA)* program. (CVAP is one of the initiatives of the AAA program.)

The CVAP Coordinator, Dr Barry White, commented that the increasing use of seasonal forecasting found in the AAA survey was highly encouraging.

He said 'The forecasts had only been around for a decade, and this is confirmation that efforts by CVAP and other agencies were paying dividends.

This is the final year of the current phase of CVAP funding. Improved

management of climate-related risks and opportunities is a major goal of CVAP'.

But Dr White thought there could still be a high proportion of farmers who might be running at unnecessarily high risk by not taking forecasts into account.

He said the challenge was to keep on with improving forecasts, how they are communicated, and practical demonstrations of their value in a wider range of regions and industries.

The overall national and industry pattern of usage as in the figure below, is likely to reflect some of the following:

- The farmer's recent experience of drought and flood.
- Industry and state agency support for seasonal forecast applications in research and extension programs.
- Opportunities depending on the nature of the industry.

- Perceptions of the accuracy of the forecasts.

Agriculture Advancing Australia is a Commonwealth Government program funded through Agriculture Fisheries and Forestry - Australia.

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surface is flat, there is only limited benefit to being precisely right.

Many cropping decisions are more uncertain than complex. This contrasts with manufacturing where there are many options and hence complexity, but the outcome for each option is certain. In dryland farming there are often fewer levers to pull, but a lot of uncertainty.

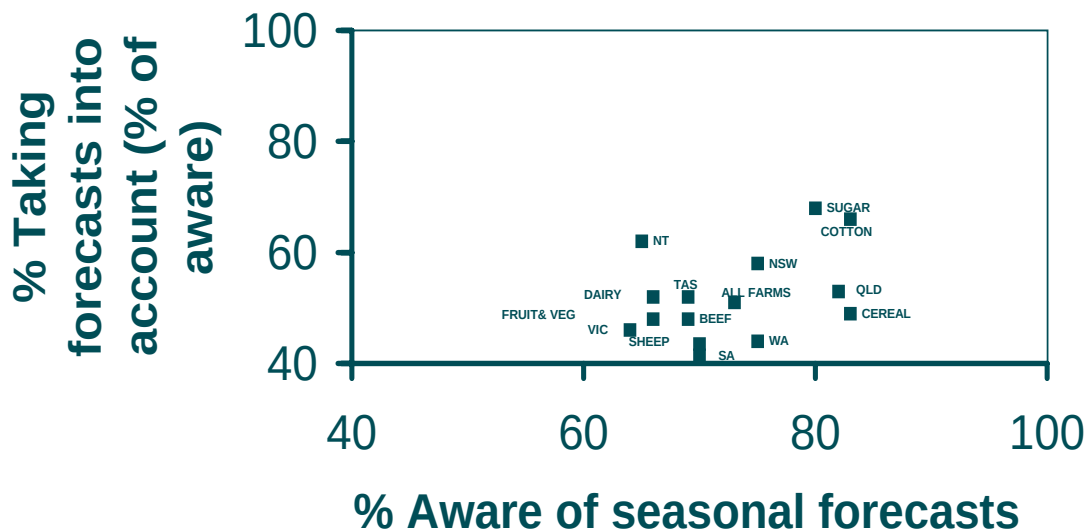
What science can do is put numbers on that uncertainty and discuss the options with farmers. This is a more modest role for science but nevertheless a worthwhile one.

If we wish to work with farmers on an issue as multifaceted as risk management, it is not a case of one way, unambiguous information flow to farmers, teaching farmers or even providing decision support for farmers.

Nor is it a case of just listening to farmers and observing what they are doing with the anthropologist's gaze.

Rather, it is a case of intervening, of joining a complex dance where it is never clear who is leading whom and where both farmers and scientists are prepared to modify and learn new dance steps as we manage farming systems in this fragile country.

Farmer awareness and use of seasonal climate forecasts



Climate forecasting — adding value to sugar marketing strategies

More effective climate predictions, prediction data tailored to the sugar industry, and a growing ability to interpret the available data are already helping to market Queensland's raw sugar and could help increase the value of the State's raw sugar exports, according to Queensland Sugar Senior Manager Technical, Dr Owen Crees.

Dr Crees said a collaborative project between scientists at the Queensland Centre for Climate Applications, CSIRO and raw sugar marketing company Queensland Sugar is investigating ways of improving sugar industry competitiveness through the use of seasonal climate prediction. The project is jointly funded by Sugar R&D Corporation and CVAP.

He said Queensland Sugar are focused on the benefits that accurate climate forecasting could provide in marketing raw sugar globally.

From a marketing perspective two critical factors stand out:

- A key issue is crop size and the amount of sugar available for sale during any season; and
- the other is the risk of disruption to the harvest due to rain, particularly at the start of the season.

"Data from the project may help us to more accurately estimate the availability of raw sugar supply months in advance, allowing Queensland Sugar to better manage storage,

shipping and specific customer requirements," he said.

Dr Crees said Queensland Sugar needs to understand the accuracy and value of climate forecasting data in relation to predicting the quantity of sugar available to assist it in long range marketing decisions.

He said that, used effectively, seasonal climate forecasting systems could be of advantage to all sectors of the industry. The benefits are derived from improved risk management and decision-making capability, in areas such as improved planning for wet weather harvest disruption and early season raw sugar supply.

"For example, both the amount of rainfall and the number of wet days during the growing season affect the size of the crop. Then, wet weather at the start of the season can interrupt the crushing, making it difficult for Queensland Sugar to meet early season deliveries to customers and maximise market opportunities.

"Similarly, having better data for the end of crushing when storage space at bulk sugar terminals is very limited would enable us to fully use our available storage," he said.

On farm, climate forecasting will also enable growers to make better use of scarce water resources in dry seasons and be better prepared for wet seasons, leading to higher sugar production.

Dr Crees said they met regularly with the researchers and operated very much in an "action learning" mode.



Initially, most of our time was devoted to identifying and understanding the climatic factors with the greatest potential to influence marketing decisions, and the strengths and weaknesses of climate prediction models as they relate to those factors.

"However it quickly became clear that conventional climate outlook data was not suited to the task and, as the process has evolved, we have begun to focus on a range of factors important in their impact on sugar production. We are also starting to study possible correlations between climate indicators and sugar cane and sugar yields using historical data. The aim is to develop a model that allows us to predict future yields from using climatic data," he said.

Dr Crees said climate and weather remained important determinants of many factors impacting on agricultural returns and the Queensland sugar industry was looking to better understand the complex climatic variables which determine their fortunes.

For further information contact the Queensland Sugar Corporation on phone (07) 3815 0100.

From left to right: Dr Roger Stone (QCCA) with Yvette Everingham (CSIRO) and Michael Jansen (Queensland Sugar) at a project meeting.

Last century - a game played in two halves

By Neil Plummer and Dean Collins, National Climate Centre (NCC), Bureau of Meteorology

The Climate Archives project (CLIMARC) is opening the lid on some hidden (but thankfully not forgotten) treasures. This CVAP-funded project aims to computerise pre-1957 daily and hourly records from 50 locations around Australia by mid-2002.

These data represent only a small fraction of the heritage of records gathering dust in National Archives Australia.

CLIMARC is a partnership between the Bureau of Meteorology, Queensland Centre for Climate Applications and a range of

supportive Federal and State agencies.

While the project is being implemented within the Bureau under the guidance of Rod Hutchinson, the project's Principal Investigator is Nick Clarkson from QCCA.

As well as improving agricultural simulation models and understanding climate risk, CLIMARC will provide the first real insight of changes in climate extremes during the twentieth century. Available monthly records show that Australia warmed and became a little wetter during the twentieth century. But little is known about changes in extremes.

The Intergovernmental Panel on Climate Change has recognised the need for an improved understanding of climate extremes. The lack of computerised daily and hourly data continues to frustrate many scientists around the world.

Since many Bureau staff have been pounding their keyboards for about two years now, we think it is about time we gave you a preview of what is being found.

The graphs (left) are from Paul Della-Marta and Blair Trewin of the NCC. These are just two of the many climate indices that are being examined as part of global climate change studies.

The dramatic drop in frost days in the Alice is perhaps less surprising given the well

documented increase in night time temperatures in recent decades.

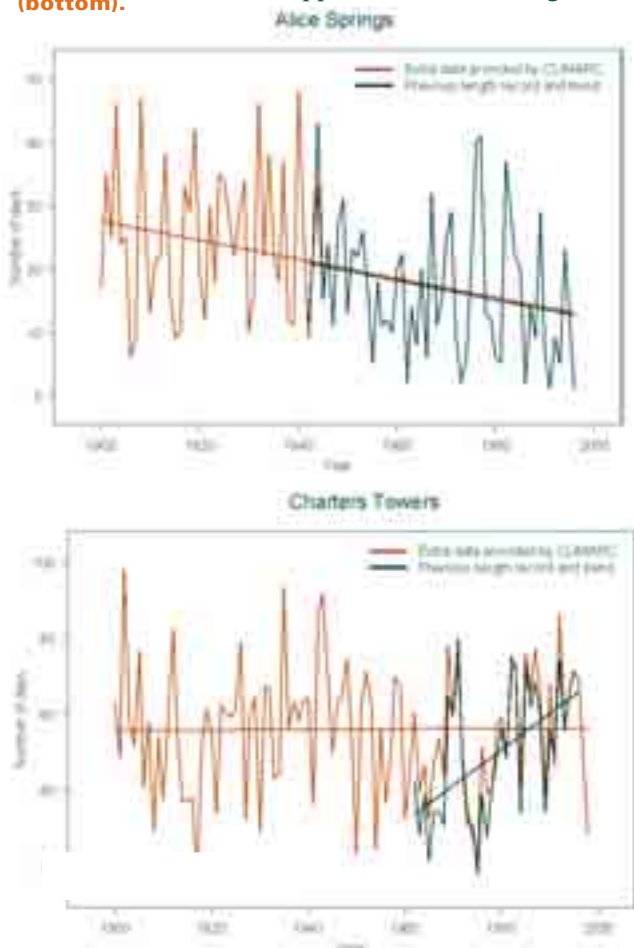
However, with regard to hot days at Charters Towers, the earlier records have shown that post-1960 trends are a poor indication of longer-term trends in this part of the world.

If these early analyses are anything to go by, it would appear that the twentieth century did indeed show some signs of a game played in two halves.

They also suggest that the next game will be even more interesting, not to say challenging.

For further information contact: Neil Plummer; Phone 03 9669 457, Email: <N.Plummer@bom.gov.au>.

Annual frequency of frost days at Alice Springs (top) and hot days at Charters Towers (bottom).



Land & Water Australia Publications

Excess stocks on a wide range of Land & Water Australia publications, including copies of publications in the Climate Variability series are available. These publications are being cleared at reduced prices, or for free.

For further details, visit the Land & Water Australia Website <www.lwa.gov.au> and click on Publications.

Feedback valued from Albury climate conference

How to better connect diverse user needs for climate information with the impressive array of climate services provided by the Bureau of Meteorology?

This was the challenge for the Cli-Manage 2000 conference in Albury, partly sponsored by CVAP. Dr Scott Power from the Bureau's National Climate Centre said the amount of feedback from those attending was quite staggering, enthusiastically given, and would be invaluable in shaping current and new services. His report follows.

The conference brought together about 140 people from across the country interested in improving the ability of Australian's to make better decisions involving climate variability. We had representatives from a wide range of industries - cattle, sugar, salt, peanuts, alpine tourism, weather derivatives, energy, water management, re-insurance and reps from numerous government departments plus some reps from NZ. We covered:

- what causes climate variability;
- what impacts has it had over the past century, what may the future hold;
- why do we give forecasts in terms of

chances and probabilities;

- what climate services and products are currently available; and
- how can they be accessed?

The Albury Conference also provided an opportunity for us to let people know about the many new and varied climate services provided by the National Climate Centre as well as other agencies. One of the main aims of the conference was to get feedback from users of our services (e.g. the seasonal rainfall outlook, the silo web-site, our web-based climate monitoring services, all of which can be reached through <www.bom.gov.au>.

We asked users:

- What do they like about our services and what don't they like.
- How could they be improved?
- What else would they like to see?

The feedback was very comprehensive. It ranged from *'keep on reducing the amount of jargon'* to *'I want more information of direct relevance to my farm'*, and *'I need faster access'*.

Many want ready access to easily understood information on the accuracy of seasonal climate outlooks. This is just a very small subset of feedback we received - we've collated comments, and we can do something about many of them. It was also pleasing to note that we have already specifically aimed projects at addressing some of the concerns above. For example, a CVAP funded

project is aimed at further enhancing the silo web-site to make it more location-focussed and more like a "one stop shop" for both weather and climate information.

For further information contact Dr Scott Power, Fax:(03) 9669 4678, or email: <s.power@bom.gov.au>.

Bureau climate locations

Seasonal climate outlook
<<http://www.bom.gov.au/climate/ahead/>>.

Wide range of products (CVAP project) <<http://www.bom.gov.au/silo/>>.

Climate monitoring
<<http://www.bom.gov.au/climate/austmaps/>>.

Climate change
<<http://www.bom.gov.au/climate/change/archive/index.shtml>>.

Masters of Climate



Unearthing better ways of using climate information to improve land management

The Albury Conference was the venue for the launch of the Masters of Climate website (visit <www.cvap.gov.au>). As part of the launch, Neil Inall interviewed three of the Masters:

- Tony Boyd from near Lake Eyre;
- Doug Lee from Proserpine; and
- Jeff Hoffman from Lockhart.

These were three of twentythree case studies showing how Australian farmers are taking on new climate tools to manage old risks. The case studies have been widely picked up by the rural media. Major features have appeared in Australian Farm Journal (April 2001), Stock Journal, Weekly Times, and on ABC TV Landline. The case studies are a valuable resource and can now be used as a basis to build on. A good example is when an industry or media journalist is looking for farmer reaction to a development in seasonal forecasting.

The Cli-manage 2000 report will be made available via the world wide web as well as in hard copy. Please contact Linda Sampson email: <l.sampson@bom.gov.au>, fax: 03 9669 4678, or phone: 03 9669 4072 if you would like a hard copy (free for participants only).

LAKE EYRE: THE ENSO INTEGRATOR

Rob Allan, formerly with CSIRO, is now with the Hadley Centre in the UK (email: rob.allan@metoffice.com).

Vincent Kotwicki is with the Ministry of Water Resources, Sultanate of Oman (email: kotwicki@omantel.net.om), and **David Roshier** (email: drosnier@postoffice.riv.csu.edu.au) is with the Johnstone Centre, Charles Sturt University.

Some background on the article is in - Allan, R.J., 2000: *ENSO and climatic variability in the last 150 years*.

Chapter 1 in Diaz, H.F. and Markgraf, V., (eds), *El Niño and the Southern Oscillation: Multiscale Variability, Global and Regional Impacts*. Cambridge University Press, Cambridge, UK, 3-56.

By Rob Allan, Vincent Kotwicki and David Roshier

Links between major floodings and fillings of Lake Eyre in northern South Australia and the La Niña face of the El Niño Southern Oscillation (ENSO) phenomenon were established back in the early 1980s. Since then, there have been important advances. (see Kotwicki, 2001 at http://www.k26.com/eyre/The_site/the_site.html).

Today, climate scientists talk about ENSO being made up of El Niños and La Niñas, which vary in their onset, duration, magnitude and cessation. This nature results from interactions between the quasibiennial (about 2 year - QB) and lower frequency (about 3-8 year - LF) components of the 'classical' ENSO signal, and is modulated further by interactions with decadal (DEC) to multidecadal (MDEC) phenomena operating in the climate system.

By combining satellite imagery with ground based observations and hydrological models, it is now possible to build up a concise picture of the linkages between ENSO and Lake Eyre floodings. Using the Southern Oscillation Index (SOI) as a measure of ENSO, Lake Eyre floodings can be matched against the SOI since 1885 (Figure 1). Major inflows of water into Lake Eyre tend to occur at times of strong positive SOI values, which are indicative of very active La Niña events. However, this relationship is not one-to-one. Indeed, there are some instances where significant inflows into Lake Eyre occur during long periods of negative SOI, or El Niño conditions, such as in the early 1910s, 1940s and 1990s. This at first may seem incongruous given the link between El Niño events and Australian droughts, but it can be explained.

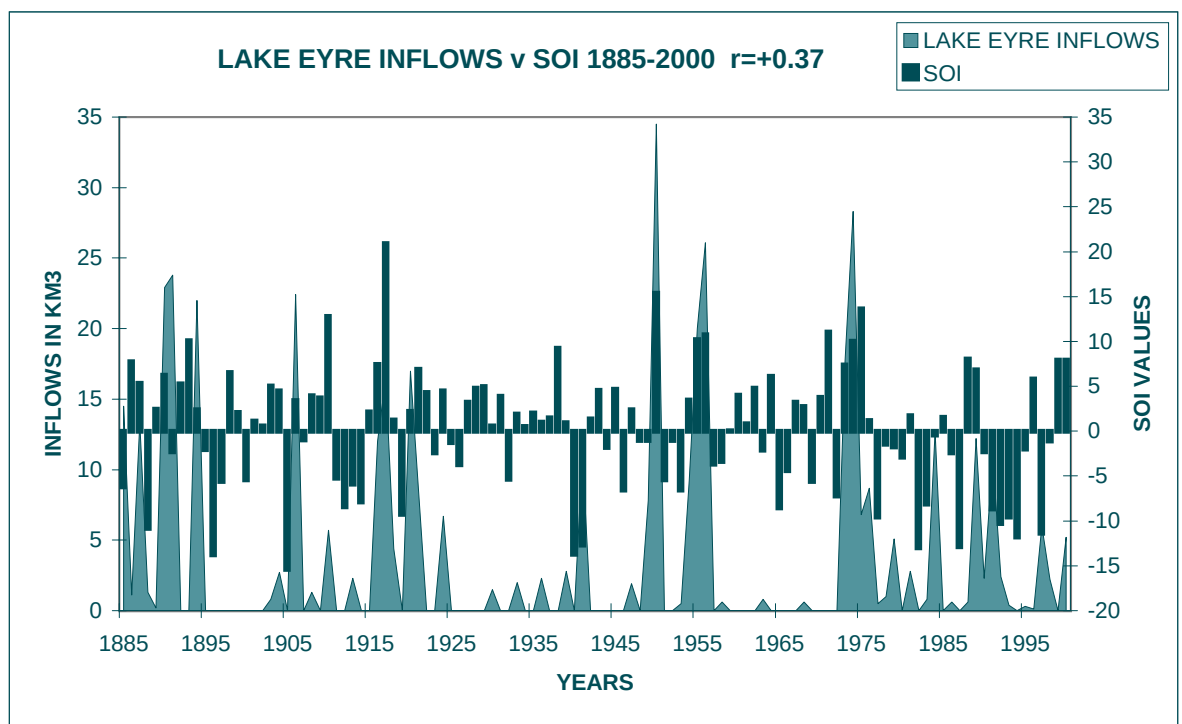
The El Niño occurrences noted above are longer lasting than the much stronger, but shorter, 1982-83 or 1997-98

events, and have been termed 'protracted' El Niño episodes. The opposite conditions, 'protracted' La Niña episodes, occurred in 1916-1918, the mid-1950s and 1970s, and since May 1998. All of these episodes may last for a number of years, as seen by the 1990-1995 'protracted' El Niño episode. However, they are not just 'classical' El Niño and La Niña events which happen to last more than the usual 18-24 months. Rather, they have been shown to occur during periods of strong interactions between 'classical' ENSO events and a decadal 'ENSO-like' signal (DEC).

To understand something about low frequency influences on 'classical' ENSO events, one must look to the patterns of anomalous (above or below average) Indo-Pacific sea surface temperatures (SSTs) which influence Australian rainfall. Figure 2 (with shadings of darker=warmer and lighter=cooler SSTs), shows SST composites during events

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Figure 1



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and episodes in the historical record for the July-September (JAS) season. Basically, the bulk of the ENSO signal during events and episodes is concentrated in the Pacific Ocean, although the Indian Ocean basin also contains ENSO influences. However, a more intriguing picture emerges from a closer examination of Figure 2.

While the ‘classical’ El Niño signal on the QB and LF bands has a pronounced warm ‘tongue’ of SSTs that covers the eastern-central equatorial Pacific, ‘protracted’ El Niño episodes are marked by warmer, but weaker, SSTs with a focus in the western-central equatorial Pacific.

Over the Indian Ocean during ‘classical’ El Niño events on the above bands, distinct SST patterns with dipoles and tripoles of warmer and cooler waters are evident. In ‘protracted’ El Niño episodes, Indian Ocean SST patterns are weaker and sometimes show almost the opposite alignments. However, the ‘protracted’ El Niño composite is also influenced by SSTs on DEC and MDEC bands.

The DEC band has SST patterns that tend to be in-phase with those on the LF band, particularly in the Pacific, where there is a reinforcement of the warm western-central equatorial SST focus. This SST pattern causes a shift in climatic regimes which, though ‘ENSO-like’, can result in more regionalised impacts of wet or dry conditions that persist for a number of years. The DEC band SST pattern over the Indian Ocean also affects these impacts.

Further aspects of the above picture need to be considered. In specific ‘protracted’ episodes, climatic signals on the QB, LF, DEC and MDEC bands can vary to the extent that a number of permutations are possible. Periods of a month or more can develop when an episode appears to be waning, only for it to become strong again.

As it wanes, conditions in the Pacific may perhaps still favour ‘protracted’ El Niño conditions, while those in the Indian may be almost like a La Niña event. For Australia, this can mean extended drought in one region and major flooding events in another (eg. as in the 1990-1995 ‘protracted’ El Niño and the 1998-present ‘protracted’ La Niña) during

the one ‘protracted’ episode. Similar patterns to all of the above are found during La Niña events and episodes, but they tend to show the opposite SST structures to those in Figure 2.

Thus it is not surprising that, when matched against the SOI, Lake Eyre inflow records respond to the full range of influences on Australian rainfall patterns generated by both ‘classical’ ENSO events and ‘protracted’ ENSO episodes.

Consequently, the relationship between ENSO and Lake Eyre floodings in Figure 1 must be seen to be even more compelling, and points to Lake Eyre as indeed being a strong integrator of the entire range of ENSO types and nature. ●

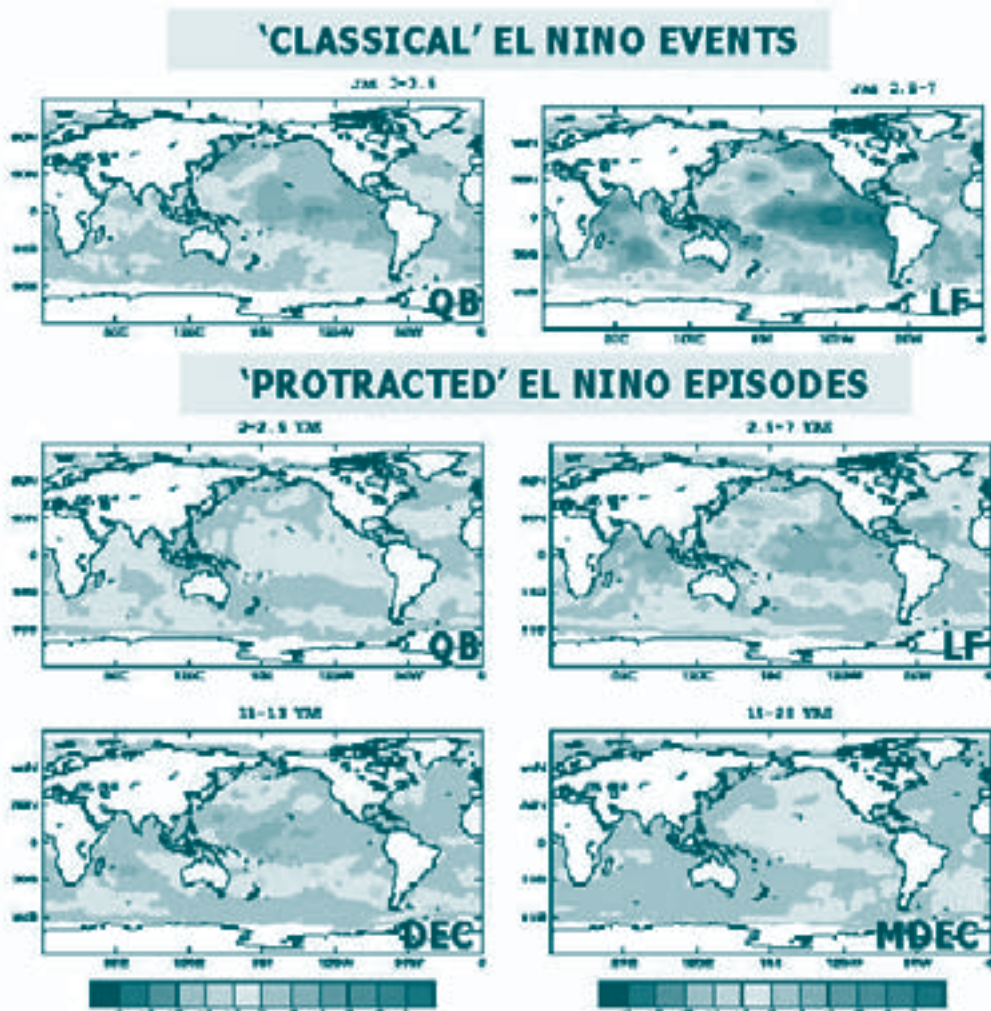


Figure 2

Is there a relationship between the SOI and winter rainfall in southern NSW and northern Victoria?

By Peter Hayman, NSW Agriculture

This report is based on a current study supported by CVAP on opportunities for greater use of seasonal forecasts in the south-eastern grain belt. The study is being done by Peter Hayman and Robert Fawcett of the Bureau of Meteorology. The current draft report will be an input into meetings in southern NSW and Victoria. The meetings will aim to develop a program of activities in research and extension which will expand promising applications of forecasts in agriculture and natural resource management.

This article is a much-condensed version. The report includes information on the Bureau's Seasonal Outlook, which includes both Pacific and Indian Ocean influences. The report also includes more detail on SOI phases from the Queensland Centre for Climate Applications. - Ed.

El Niño Southern Oscillation (ENSO) is seen by many farmers and agronomists in the southern grains belt as a northern NSW and Queensland phenomenon and, like strange codes of football, of curiosity value only.

Nevertheless, there is good evidence that the ENSO does have an affect across the Eastern grains belt into southern NSW and northern Victoria. Spatial analyses of

winter spring rainfall for the last 12 El Niño and 12 La Nina events <<http://www.bom.gov.au/climate/ahead/soicomp.shtml>> shows the gradient on the Australian grains belt is clearly from east-west, not north-south.

Meteorologists have long been aware that northern Victorian winter-spring rainfall is subject to tropical influence. Dr Bill Wright from the Bureau of Meteorology showed that about 40-50% of the total winter rainfall in the region was due to interaction of cold fronts with tropical and extra

relationship between SOI and rainfall is variable from location to location, but that there is not a clear north – south gradient. As shown in Table 2, the simultaneous correlation is marginally stronger in the south than the north. Despite the relatively low correlation, the chance of exceeding the median shifts from about 25% when the SOI (May to October) is below -5 to 75% when the SOI is above +5.

Does persistence pay?

A simple forecasting approach (persistence) is to use the rainfall in May, June and July to predict the rainfall of August, September and October. Table 2 shows that this persistence is stronger in the south than the north. However, the SOI in June and July, is a better predictor of spring rainfall than persistence at all locations. The maps of the chance of exceeding the median rainfall from QCCA show that the strongest shift in probabilities for Spring rainfall are in northern Victoria. <<http://www.dnr.qld.gov.au/longpdk/phases/pmaps>>.

The nuances of the nineties

The analyses reported so far have relied on 100 years of data. Farmers and advisers do not experience 100 years, they experience the last decade. In Figure 1, the May to October rainfall for Dalby (black bars) and Benalla (white bars) are compared. The relationship is not perfect, there are a number of “miss-matches” when the SOI was negative and the season was wetter than average or visa versa . In

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Table 1. The relationship between rainfall and the SOI in eastern Australian Grain regions

Location	May to Oct rain	
	Average (mm)	Correlation with SOI (May to Oct)
Emerald	180	0.42
Roma	219	0.51
Dalby	241	0.42
Moree	239	0.43
Walgett	204	0.48
Gunnedah	268	0.42
North Average	225	0.45
Dubbo	279	0.51
Condobolin	219	0.50
Cowra	311	0.52
Yass	352	0.45
Wagga	314	0.47
Jerilderie	227	0.47
Central Average	284	0.49
Albury	426	0.49
Benalla	412	0.53
Seymour	362	0.53
Rochester	265	0.51
Birchip	231	0.48
Horsham	285	0.43
South Average	330	0.50

tropical cloudbands. During an El Niño event there are fewer cold fronts that reach as far north as northern Victoria and southern NSW (they only get as far north as Melbourne). During a La Niña, not only are there more cold fronts reaching the region, they interact with moisture from a variety of cloudbands which extend from tropical regions.

The SOI and rainfall

Table 1 shows that the simultaneous

Table 2. Comparisons of seasonal rainfall predictions

Seasonal rainfall item	Eastern Australian grain region (for locations as in Table 1)		
	Northern	Central	Southern
<u>May to October rain</u>			
Average (mm)	225	284	330
Correlation with SOI	0.45	0.49	0.50
<u>August to October rain correlation with</u>			
May to July rain	0.07	0.14	0.26
June to July SOI	0.27	0.38	0.42
<u>% chance of Aug to Oct rain > median if</u>			
May to June rain > median	50	55	62
June/July SOI phase is negative	23	21	19
June/July SOI phase is positive	69	67	71

(continued from page 10)

the early 1990s a farmer in Benalla could read in the rural press of the ongoing drought in southern Queensland and the consistency of this drought with a negative SOI.

However, farmers in Benalla (and Wagga) were experiencing average to wet seasons in 1990 to 1993, it was not until 1994 that all of Eastern Australia was affected by an El Nino drought and in the 1997 El Nino, timely rains saved most of the eastern wheatbelt.

In 1995, 1999 and 2000 the average SOI was between +5 and -5, and 1996 was a wetter season in both locations. In 1998 when the north had floods, most of the south had a slightly drier season.

Table 2 showed that, using the last 100 years, the correlation between May to October rainfall and SOI is marginally higher in the south ($r = 0.5$) than the north ($r = 0.45$) for 100 years. However, during the 1990s, the correlation was

much higher in the north ($r = 0.5$) than the south ($r = 0.2$). Ten years is a short time to climate science, but it is longer than most farmers would give a new innovation.

The decadal factor

Farmers in the southern region will benefit from further understanding of the Indian and Southern Ocean, however a couple of mismatches in the

early 1990s may mean that they dismiss the influence of the Pacific Ocean and the SOI.

New research on decadal variation may explain why the 1990s were not a good time to be promoting or following the SOI in the south-eastern region, but suggest that we are moving into a period when the skill is likely to be stronger.

From skill to value

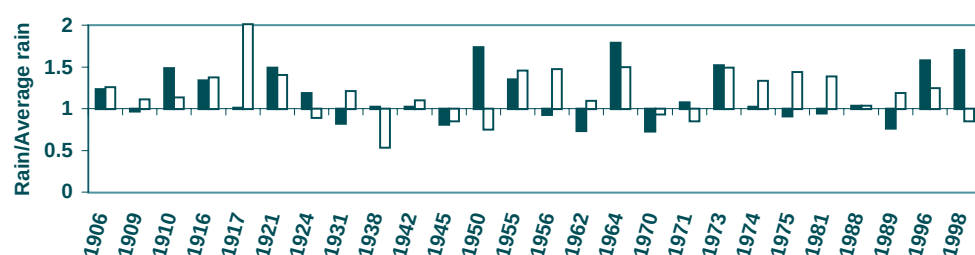
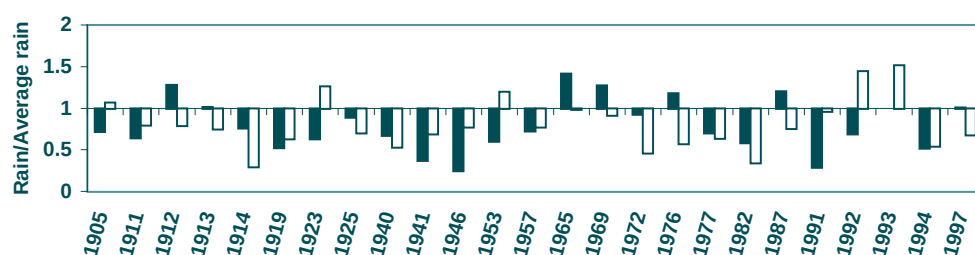
The most common reason given for the north-south gradient in the use of seasonal forecasts is that they work better in the north than the south.

However, we found little evidence for a north-south gradient in the *skill* of ENSO based forecasts.

The question of the *value* of seasonal forecasts, can only be answered by farmers and agronomists working in the south-eastern grain belt.

For further information contact Dr Peter Hayman at NSW Agriculture on phone (02) 6763 1256, or email <Peter.Hayman@agric.nsw.gov.au>.

Figure 1. Rainfall for May to October at Dalby (black bars) and Benalla (white bars). Rainfall is the ratio to average. Only years when SOI > +5 (lower) or < -5 (upper) are shown.



Learning Risky Business



Players at
Geraldton, WA

By Dr Ross Kingwell

We often hear “you learn best by doing” or we talk about “hands on” experience, so it seems experiential learning is valued. In the CVAP project “Risky Business” we used experiential learning techniques to promote among farmers and those serving farmers a better appreciation of the impact of price and climate variability upon farm management.

We developed “Risky Business”: an intensive, fun-filled one day interactive workshop. The workshop utilises a computer-based farm management game that incorporates price and climatic variability.

The workshop

Each participant (or small group of participants) is given a farm to manage. Every player is given an identical hypothetical farm so everyone starts off on the same foot. Everyone then receives information about price and climate forecasts for a coming season. Participants are also given an opportunity to buy additional confidential seasonal forecasts. Then each player decides on the mix of farm enterprises and farm input levels for their farm in the

coming season. At this stage the participants are busy formulating farm budgets to see how best to generate high profit.

Then comes the crunch! After all players have submitted their farm plans, the actual prices and yields for the season are revealed. Depending on the nature of the season that unfolds, cries of anguish, squeals of delight or gentle mumblings are heard from the players. Some have made a profit, others a loss. Talk about experiential learning!!

Kingwell et.al. (1993) found that getting tactical decisions right in the occasional highly favourable seasons can do a lot for achieving farm family aims. How best to manage businesses to exploit the consequences of risk/volatility on those who manage it less adeptly than their competitors remains one of the great neglected questions of the past fifty years of farm management in Australia. (Bill Malcolm, Uni. Melbourne)

Practical lessons

The players manage their farms through several seasons and learn many practical lessons:

- decisions in previous seasons can constrain your choices in a current season;
- farmers make a lot of money in often only a few seasons;
- the pattern of seasons can have a huge effect on farm profits;
- decision-making is stressful;
- it's not always easy to learn from your neighbours;

- seasonal forecasts can be wrong but often they're worth noting.

CVAP have funded over 17 workshops which have been held in WA, SA, VIC and NSW. Feedback from participants has been very positive.

Publications

V. Stewart, S. Marsh, R. Kingwell, D. Pannell, A. Abadi and S. Schilizzi (2000), Computer games and fun in farming systems education?: A case study, *Journal of Agricultural Education and Extension* 7(2): 117-128.

Marsh, S.P. (1999). Salty Business: A game to illustrate concepts about managing risk in a salt-affected farmland catchment, *SEA Working Paper 99/10, Agricultural and Resource Economics*. Downloadable from <<http://welcome.to/seanews>>, Issue#5, Nov, 1999.

Contact Persons

The “Risky Business” workshops can be presented by Dr Ross Kingwell, phone (08) 9368 3225; email: <rkingwell@agric.wa.gov.au>, Dr Amir Abadi, Touchstone Consulting, phone: 0413 567 121; email: <aabadi@agric.uwa.edu.au>, and Mr Mike Krause, Applied Economic Solutions, phone (08) 8396 7122; email: <mike@AppES.com.au>.

WA Research Paper

‘An assessment of the value of seasonal forecasting technology for Western Australian farmers’ E.H. Petersersen and R.W. Fraser. The paper was presented at the 2001 Adelaide Conference of the Australian Agricultural and Resource Economics Society. For further information contact: <Liz.Petersen@anu.edu.au>.

Can agribusiness utilize better information on climate variability?

Insurance and loss assessment were the most promising applications in a recent CVAP project, according to CSIRO researchers Peter Carberry and Lisa Brennan.

External evaluator Peter van Beek, SyTrec Consulting, said the recently completed CVAP project with agribusiness had succeeded in its objective. This was to demonstrate the value of seasonal climate forecasting and systems simulation tools (which had been developed with farmers) within a variety of agribusinesses. The core capacity of the APSRU simulation models is to simulate the observed variation in crop yields for a wide range of environments and inputs.

The project (CTC18) employed a participatory action research approach in which researchers worked

with staff from five major agribusiness companies. They tested the use of climate forecasts and cropping systems simulations in business operations. Case studies included applications in marketing, financial lending, insurance and portfolio management.

Clear interest in progressing the commercial application of these tools was most evident in the insurance and loss assessment applications. The major hurdle for banking and portfolio analysis applications was how to develop in-house capacity for using these tools. In marketing, there appeared to be little incentive for companies to replace existing systems which are based on flexible and transparent information networks.

The researchers said that working with agribusiness

required learning new ways of research engagement, bridging differences between organisational cultures and protocols.

Nevertheless, they saw good opportunities remaining for further exploring the application of seasonal climate forecasting and systems simulation in assisting agribusiness operations to provide better services to Australian farmers.

For further information contact Dr Peter Carberry, Agricultural Production Systems Research Unit (APSRU) on phone (07) 4688 1377, or email: <peter.carberry@cse.csiro.au>.



Agribusiness researcher Dr Lisa Brennan of CSIRO - Lisa presented papers on the project at the Australian Agri-food Congress 2000 Forum and the AARES 2001 Conference.

New climate research at Newcastle

MEI - a promising tool

The Multivariate ENSO index is doing better than the SOI in tests by the University of Newcastle. Hydrology impacts group members Stewart Franks and Anthony Kiem said their research has focussed on delivering useful climate insights to the water industry.

It is partially funded by Hunter Water Corporation, and includes the hydrological and flood risk implications of climate variability and change. In local and Australia-wide comparisons, the Multivariate ENSO index (or MEI) has been shown to significantly outperform the traditional SOI in predicting October-March

rainfall and runoff totals with up to 9 months lead time.

The MEI index, available from 1950 onwards, is comprised of a number of climate and SST parameters that characterise ENSO events, whereas the SOI only uses atmospheric pressure differences. This leads to apparent ENSO events in the SOI that do not result in the expected impacts.

In all cases, the MEI shows higher predictability. Current research is evaluating the utility of a pro-active minimal water restriction policy based on MEI-ENSO forecasts, in avoiding stricter reactive consumption restrictions. (to be published in *The Hydrological Sciences Journal*).

Decadal variability and flood risk

The Newcastle group has also evaluated the New South Wales flood records in the light of multi-decadal variability. From 41 gauges, the results show a marked step-change in 1945 with flood risk increasing, on average, by a factor of 2.

These results invalidate traditional flood risk estimation techniques meaning estimated flood risks are subject to large uncertainties. Statistical methods are currently being developed that explicitly account for 'climate state', to derive a more appropriate quantification of flood risk (to be published in *Water Resources Research*).

For further information contact Stewart Franks, email <ceswf@civeng.newcastle.edu.au>.

Getting the odds across - a better way

Changing the way forecasts are presented helps understanding, according to research by Will Coventry. In a CVAP-funded project, researchers from the School of Psychology at the University of Queensland have identified where some farmers have difficulty in their understanding and interpretation of climate probabilities. Simple approaches overcome the complications.

During February 2001, 73 farmers from Southern Queensland and Northern NSW were tested to investigate their understanding of Seasonal Climate Forecasts (SCF) and their use in crop planting decisions. One of the more surprising findings was that when farmers were presented with the SCF of “a 30% probability of getting above median rainfall”, 29%

of the farmer’s incorrectly believed that rainfall would actually be greater than the median by 30%. A greater understanding of climate-forecast probabilities meant greater use of forecasts in decisions. Greater use was associated with a more favorable attitude to forecasts that were seen as inconsistent (in the sense of the less probable outcome eventuating). A farmer, who understands probabilities, recognizes it is legitimate for the forecast and season outcome to be ‘inconsistent’. However, limited probability understanding means a farmer is less accepting when the forecast is ‘inconsistent’ with the season outcome. This contributes to a

more unfavorable attitude towards these particular forecasts and subsequently, less use of the forecasts in their decisions.

These misunderstandings of probability forecasts can be overcome by approaching the way probabilities are presented. The findings of our surveys conducted in August 2000 illustrated the effectiveness of the frequency format over the single event probability format.

Single-event probability	Frequency
Based on a positive SOI phase in February-March, the probability of getting above median rainfall in the next three months is 60%.	The SOI was in a positive phase in February-March and there has been 25 years in the historical record when this has occurred. In 15 of these 25 years (60%) rainfall was above the median in the three months that followed.

Odds and Sods

‘I have never decided beforehand what research I shall do - research has always found me...’ Climatologist Prof Joseph Gentilli, 1912-2000.

‘I can calculate the motions of the heavenly bodies but not the madness of the people’ A hapless Isaac Newton in 1720 before the collapse of the South Sea Company.

‘Farmers only worry during the growing season. But townpeople worry all the time.’ EW Howe.

‘The second mouse gets the cheese.’ (Anon)

‘Record floods from non-record rains’. Northern NSW farmer describing last summer.

12,461 mm (41 ft), the Australian record calendar year rainfall at Bellenden Ker in the La Niña year of 2000, the wettest since 1974. (data from National Climate Centre, B of Met)

‘I hate records as a rule, but I respect miracles’. Cardus after Bradman and Ponsford scored a total 839 in successive partnerships against England.

‘No cricketer has ever had a career remotely like his, and (this is stated as unequivocally as probability could ever allow) no cricketer ever will’. Charles Davis on Bradman.

Inklings benchmarked - *‘It is hard to believe that benchmarking as an ‘analytical’ activity would have been given its recent third life in Australian agriculture if benchmarkers had even a vague inkling of the whole farm approach and the production economic way of thinking about production processes.’* (Malcolm 2001)

Beyond benchmarking - *‘So in short, you can’t prove anything by one occurrence, or two occurrences. Everything has to be checked out very carefully. Otherwise you become one of these people who believe all kinds of crazy stuff, and doesn’t understand the world they’re in.’* Richard Feynman in *‘The meaning of it all’.*

Sacked forecaster explaining why he left his last job - *‘The climate did not agree with me’*

The results indicated the frequency format

- provided the clearest understanding of the forecast;
- was preferred by farmers for conveying the forecast to other farmers; and
- reduced the perception of forecasts as misleading when the season outcome and forecast were inconsistent.

This finding has since been supported by our more recently collected data which found a significantly greater use of forecasts in decision making if presented in the frequency rather than the single-event probability format. While the frequency format is beneficial, our experiences have provided strong anecdotal

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Darwin hosts 2001 ANZ Climate Forum

The theme of 'Life in the Tropics' sets the stage for the first forum to be held in Darwin. The 18-21 September forum is an ideal venue for both established and younger scientists involved with climate science and applications.

Conference organisers Hakeem Shaik and Peter Bate said that the emphasis is on work in progress, and the scope includes environment and ecology, extending to the impact of climate and climate science on fields such as agriculture, human health, the building industry and education.

In addition to Australians and New Zealanders, contributions are particularly welcome from elsewhere in the Asian and Indian and Pacific Ocean regions.

Darwin has long had global significance in terms of meteorological observations. Dr. Gilbert Walker chose the pressure observations from

Darwin for his studies of atmospheric teleconnections, as they were very consistent from 1882.

This led to the SOI and Darwin's climatological significance. Egypt has long had the Nilometer which gave a reading of the rising of the Nile, and thus a seasonal forecast for the Egyptian economy.

The Darwin barometer has a similar but perhaps less exalted function, its pressure reading half defining as it does the Southern Oscillation Index (SOI being based on the atmospheric pressure difference between Tahiti and Darwin).

For further information, please see the ANZCF2001 Web site at: http://www.bom.gov.au/weather/nt/inside/anzcf_2001/index.shtml.

Alternatively, contact Dr Hakeem Shaik (BoM Climate & Consultancy NT) on phone (08) 8920 3814, or email anzcf2001@bom.gov.au.

AFFA Science awards for Young People

Applications are invited by 15 June to outline a proposal about how the award would be used. There are a range of awards including some from R&D Corporations. Projects are to be on an innovative or emerging scientific issue. (A good example would surely be a farmer with a proposal on a novel application of seasonal forecasting.- Ed.)

Further details are at the science awards logo on www.affa.gov.au.

Seasonal Forecast project in south Asia

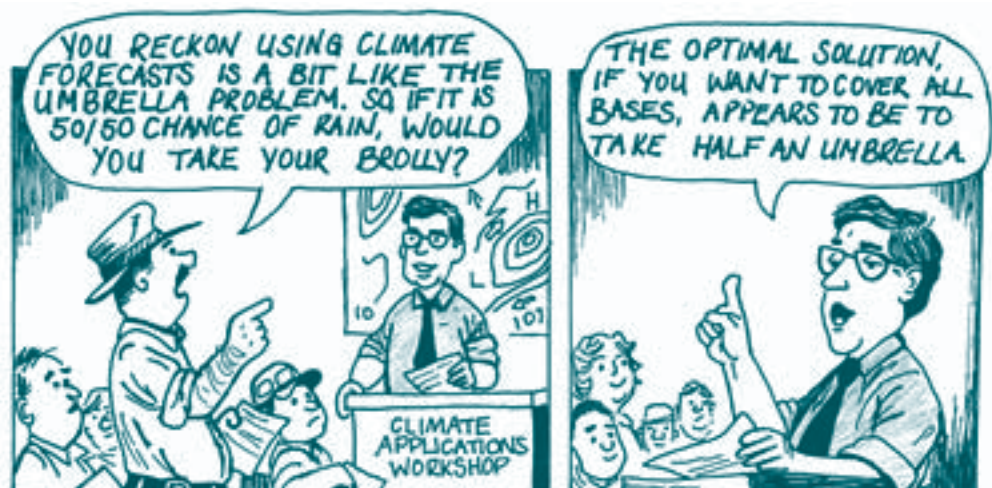
Connecting climate science with small holder dryland farmers in south Asia is the focus for a project led by Australian researchers. Project leader Dr Holger Meinke (also leader of the CVAP decadal project) said the project was an Asia Pacific Network initiative. He would be working with scientists and farmers, particularly in India and Pakistan.

For further information contact Dr Meinke at APSRU, Toowoomba, email: meinkeh@dpi.qld.gov.au.

The Titanic, the Irish Famine and the Weakest Link

April 1912 when the Titanic set sail with the SOI at -21, and icebergs presumably further south than normal. The Irish Famine of 1845-46 and the crazy weather that spread the potato blight linked to a possible El Niño. Hitler in Napoleon's footsteps of 1812 (yes, a possible El Niño) invades Russia during a protracted El Niño in the early 1940s. All this and more in 'El Niño - The weather phenomenon that changed the world.' (Ross Couper Johnston, Hodder and Stoughton, 2000).

Two bob each way



When overcast is overcast?

The forecast of 'overcast' is bad for business, according to a Brisbane manufacturer of pleasure boats. He said business would prefer that terms like 'overcast' be replaced with 'Fine but cloudy' and the chance of rain be in %. (The Australian, 4/4/01).

The implication was that weather forecasts were too general and too gloomy, even over predicting rain, or overcasting. There are a couple of Australian examples where % probabilities are used. One is the long-running Canberra trial for weather, and the other is seasonal climate forecasts.

Overcasting can be a problem in its own right. If you are a drought forecaster (and don't use probabilities), one way to get your hit rate up on the cheap is to forecast droughts a bit more frequently than they have occurred. But you have to put up with more sorry's of the false alarm type, not unlike 'El niño que exclamó el lobo' - the boy who cried wolf.

Autumn is the time to more keenly watch the Pacific, and the models doing the forecasting. There are several models forecasting sea surface temperatures. One will be right, but which one? Similar to the first swallow of spring,

the annual autumn watch is for the first press sighting of an El Niño alert, and a correct call. Early March saw the Sunday Mail (4/3/01) come out with the headline 'El Niño drought warning'. Late in March the Weekend Australian (24-25/3/01) headlined 'Early signs point to a new El Niño'.

The story in the Pacific is just one aspect. The users of the forecast want to know the chances of a drought at their place, and perhaps something of the more global market impacts. How autumn sea surface temperatures in the eastern Pacific evolve is still in part 'between the devil and the deep blue sea'. History does tell us that when an El Niño has locked in, there is a big upswing in the chance of a drought, particularly in eastern Australia. But it is still not possible to pin down where the wandering footprint of a particular El Niño will land as a drought.

Nevertheless, much progress has been made in the last decade in developing and using climate forecasts. Indeed, some other forecasters may have cause for envy. Barry Hughes (in *The Australian* recently) resurrected the 1970s Treasury retort to criticism from the Melbourne Institute

that official economic forecasters had missed the last two recessions. Their retort - 'Better than forecasting seven of the last two downturns'. -Ed.

(continued from page 14)

evidence suggesting that a more thorough and adequate understanding of probability forecasts can usually be gained by briefly presenting or explaining how the forecasts are calculated using a frequency explanation such as the historical bar graph.

For further information contact Will Coventry on phone (07) 3365 6774, email <will@psy.uq.edu.au>.

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PP255003/04168

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DAD AND DEL

