CSIRO Land & Water/Greg Heath

Dried-up ideas: our changing approach to drought

As the latest long dry lingers on, and a familiar story of rural hardship repeats itself, **Steve Davidson** looks at our entrenched reactions to this latest drought episode. But what are re-focused attention on policy, better understanding of climate changes, and an evolving, more adaptive attitude to Australia's natural cycles teaching us about how to live with worsening drought?

The bad news is that drought, in several respects, may be getting worse in many parts of Australia; the good news is that our collective knowledge of drought and how to predict and manage it, especially in an agricultural context, is burgeoning.

Since about 1989, the message that in this country drought is a normal phenomenon, not a freakish natural disaster, has been slowly getting out, but not really widely accepted. This is especially so in the media. 'Climatic variability', the term preferred by scientists, just doesn't sound right in a headline. And farmers stand to benefit if governments declare Drought Exceptional Circumstances and financially assist farmers in times of drought, so the concept of drought as a cruel and unexpected climatic quirk is difficult to shake off.

Is drought really getting worse? If so, how and why? What have we learned about drought in recent times and in what ways is this new wisdom being applied?

A tough environment

In a contribution to the newly released book, *Beyond Drought: People, Policy and Perspectives*, Dr Mark Stafford Smith, formerly with CSIRO Sustainable Ecosystems, makes the point that our continent lies in a particularly variable part of the earth's climate system. It is a tough environment for agriculture.

'An Australian farmer living in, say, our semi-arid zone, will experience much greater diversity in significant rainfall events than a United States farmer at a site with comparable mean annual rainfall and about the same seasonal rainfall regime,' says Stafford Smith.

'We have whole layers of climatic variability here,' he says. 'On top of the normal annual variability you get in all semi-arid areas of the planet, Australia has to put up with sources of multi-year variability such as El Niño. Climatologists now recognise longer-term variability that is modulated by the 'Inter-decadal Pacific Oscillation' (a 15–30-year fluctuation in sea surface temperatures and circulation across the Pacific Ocean), and this, in turn, is affected by other long-cycle events in the world's oceans. As well as all this, we are facing climate change due to global warming.'

Our native flora and fauna are beautifully adapted to this harsh variability. However, by the very act of intensifying land-use – from, say, Aboriginal exploitation of native animals, to pastoral grazing, to intensive agriculture – we have gradually replaced the ecosystem's buffering capacity with imposed management. The process of obtaining higher productivity from the system reduces the landscape's inherent resilience to shocks like drought.

Progress

Climate change, drought and agriculture

Is climate change leading to more severe or frequent droughts? The latest word on this comes from the book, *Climate Change: An Australian Guide to the Science and Potential Impacts*, published by the Australian Greenhouse Office (AGO), with contributions from leading CSIRO, university and other researchers.

Avoiding here, in *Ecos*, the issue of defining drought (150 different definitions have been documented), recent research supports the idea that the enhanced greenhouse effect or global warming is already affecting occurrence of Australian droughts.

In 2001, the Intergovernmental Panel on Climate Change stated that increased summer continental drying and risk of drought is likely in most mid-latitude continental interiors. Sure enough, observed trends in our climate in the latter half of the 20th century do indeed indicate reduced rainfall in the southern mainland and in the far east of Australia. What's more, during this period, the observed warming trend has become increasingly similar to that projected by climate models that include the enhanced greenhouse effect.

Dr Neville Nicholls of the Bureau of Meteorology has also documented a trend towards increased annual average surface temperatures over Australia for the same annual average rainfalls. This means that higher temperatures and hence higher potential evaporation are occurring during droughts. Not what we want to hear.

S Davidson

Water is a precious resource and competition between user groups is intensifying.

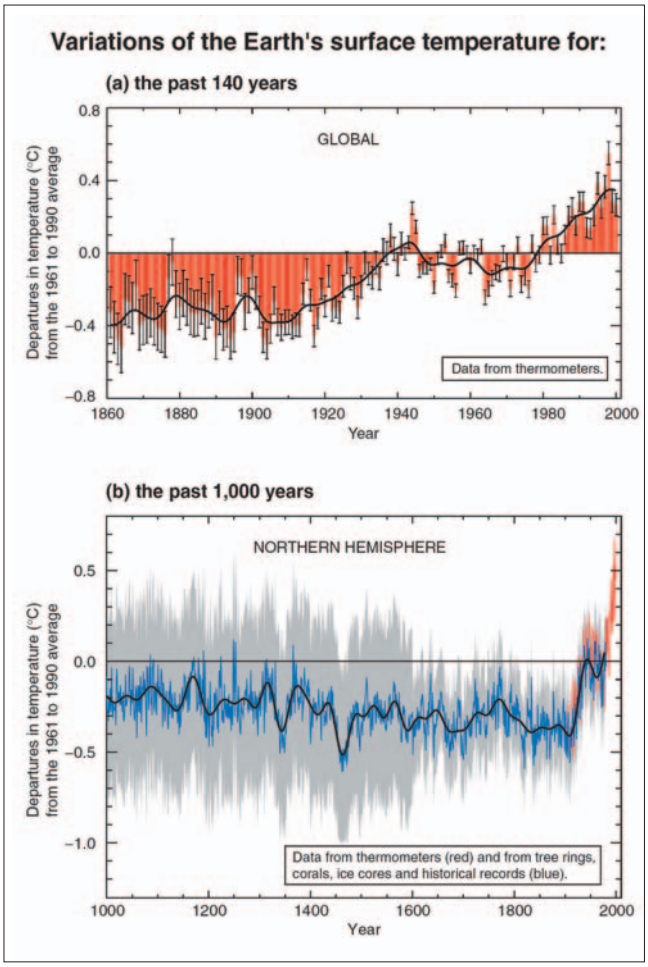
Dr Penny Whetton and Dr Ramasamy Rupiah, both of CSIRO Atmospheric Research, say that with most climate models, under greenhouse conditions tending towards decreases in annual average rainfall in the south-west, parts of the south-east, and Queensland, and increases in temperature and potential evaporation across the continent, the current situation where annual evaporation exceeds rainfall for most of Australia is exacerbated.

'This means that future increases in drought intensity are likely even in those regions where average annual rainfall may increase with global warming,' warns Whetton.

Other results from enhanced greenhouse computer simulations predict marked decreases in runoff over most of mainland Australia, including the vital Murray-Darling Basin, as warming occurs. One simulation in particular, showed decreases in both maximum and minimum monthly runoff, implying much more frequent droughts. Another simulation indicated possible river flow reductions of 12–25% by the year 2050.

Rising temperatures in the Murray-Darling Basin, since at least 1952, have increased the severity of drought, for a given rainfall deficiency, through further or more rapid reduction in soil moisture and greater water demand. Certainly, extremely high temperatures, fires and dust storms exacerbated the impacts of the 2002–2003 drought (report by AGO and David Karoly[1]).

Climatic changes seem likely to trigger more frequent drought. Fortunately, perhaps, the potential impact of drought on the Australian economy has declined in parallel with the importance of agriculture in the economy, but present climatic variability still causes fluctuations in the GDP of about 1–2% ($6.6–13.2 billion) and affects rural families and businesses.



IPCC http://www.ipcc-wg2.org/index.html

Global warming is with us and although the temperature values seem numerically small, they are very significant climatically.

However, Dr David Jones, of the Bureau of Meteorology, points out that the combination of growing urban populations and scarcer water resources due to climate change could spread the pain of droughts from our rural heartland to city centres. This raises the prospect of new social and economic problems and, at worst, could lead to future caps on development in some regions.

The AGO publication states that although Australian farmers have partly adapted to El Niño-related droughts, they depend on good years for recovery. This means farmers and the communities that service them are 'quite vulnerable to any increase in the frequency of drought or to a tendency for droughts to last for a longer period.'

Recently, research has even given rise to commercialised management tools to assist

1 See http://www.maths.monash.edu.au/~ris/publications/bamos.pdf

landowners and climate modelling is becoming ever more fine-tuned and informative. Climate science is helping us adapt to drought by providing increasingly accurate seasonal and long-term climate predictions and forecasting for agriculture and other sectors of the economy (AGO report).

Adapting: WifADs in the kitchen

Dr Peter Carberry and his colleagues at the Agricultural Production Systems Research Unit (APSRU), a joint CSIRO-DPI-University of Queensland research centre in Toowoomba, Queensland, have been working with farmers since 1991 to introduce computerised decision-support systems that allow them to better manage climatic variability, including drought … and their innovative approach is paying dividends.

'From the start, we aimed to enhance farmer decision-making by developing and delivering computer-aided farm management systems which are based on scientific models intended to enhance farmer decision-making,' says Carberry. 'Our philosophy was to take our research onto farms and participate with farmers in exploring their real-world issues. It is a two-way learning process.'

He recalls how the idea first started when fellow scientist, Dr Bob McCown, suggested he take his computer along to a meeting with a particular farmer to run the researchers' simulation model interactively with the farmer. This had not been done before and Carberry set up his then very user-unfriendly computer model on Mr Ross Skerman's kitchen table with some trepidation.

They were reviewing the results of the previous year's on-farm trial on his dryland cotton crop when Skerman asked 'that first important question':

'I wonder what would happen if I could've planted my cotton at a more preferred time (early October)?' They ran the simulation to answer the question – a higher yield in that year – and more 'what if' questions and computer scenarios followed.

'The WifAD or interactive "What if? Analyses and Discussion" was born,' says Carberry. 'That first kitchen table session was followed by hundreds more and we had discovered a real role for computer simulations of agricultural systems. That participatory approach is now widely adopted in Australia and internationally … and not just in agriculture.'

In terms of coping with drought, the Unit's FARMSCAPE program, and the

Are we in a decades-long dry?

Are we experiencing the mother of all dry spells in southern Australia?

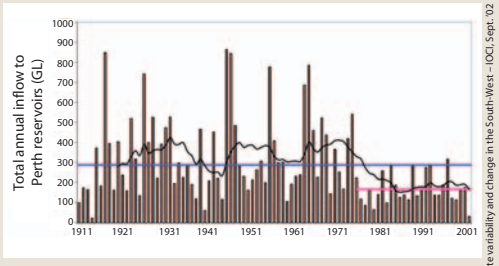
We usually think of climate change as a gradual process. However, somewhat disturbingly, climatologists have documented a sudden, sharp and sustained drop in rainfall in the south-west of Western Australia since the mid-1970s. Mr Brian Sadler, Chair of the Indian Ocean Climate Initiative (IOCI) Panel in 2002, when it reported on the phenomenon, says 'research on global warming suggests this region is at the front line of expected change in rainfall in southern Australia over coming decades.'

The IOCI report found that, in the south-west WA region, winter rainfall suddenly decreased about 30 years ago by about 15–20%. It was not a gradual decline, more of a switching into an alternative rainfall regime. This, in combination with a gradual warming over the last 50 years, has lead to a massive 50% fall in stream flow in the region. Extreme (heavy) daily rainfalls have also become more rare.

IOCI scientists say the decrease in rainfall, and associated changes in global atmospheric circulation, resemble changes most climate models project for an enhanced greenhouse effect. However, they say that the sudden drop in rainfall is most likely due to a combination of natural variability and enhanced greenhouse.

Dr Brian Ryan, of CSIRO Atmospheric Research, agrees that the decades-long depression in rainfall may reflect natural variability. He concurs that researchers cannot conclude, beyond all reasonable doubt, that the enhanced greenhouse effect is solely responsible for the sudden drop in rainfall.

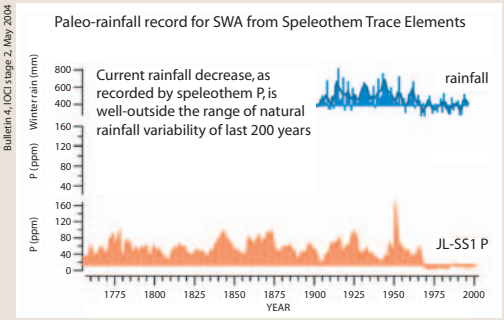
A recent preliminary study of trace elements in limestone caves on the Leeuwin-Naturaliste ridge in south-west WA, by Dr Treble of the University of California (UCLA), indicates that low rainfall in the region since 1965 is well outside the range of natural variability in rainfall over the last 200 years. The data look clear-cut and lend more weight to the view that greenhouse effects might be responsible for the current dry climate.



Low river flows into Perth's reservoirs over the last quarter of a century, due to the absence of replenishing winter rains, have meant that the city's water supply has become unreliable.

The very long dry, still ongoing, has important implications. Illustrating this, in the mid-1980s water managers and planners started worrying about the dramatically decreased inflows to Perth's reservoirs since 1975. By 1996, it was decided to accelerate development of new water resources, at a cost of more than $500 million, and sharpen earlier initiatives to reduce demand. Groundwater utilisation has increased. Managers of water allocations and wetlands are also having to respond to the challenge.

More recently, research undertaken in the Bureau of Meteorology has shown a similar downward trend particularly in April–July rainfall in parts of south-eastern Australia. According to Dr David Jones the trend seems to have strengthened since 1997, leading to water shortages across Victoria and very large declines in runoff in most river systems, to levels never before witnessed. He says it is consistent with a recent trend towards increasing atmospheric pressures over southern Australia and with changes expected under increasing greenhouse gas concentrations.



Preliminary studies of trace elements in limestone caves in south-west Australia suggest that rainfall during recent decades has been well below anything seen since Captain Cook's day.

More information:
Climate variability and change in south-west Western Australia (2002) Indian Ocean Climate Initiative Panel, Perth. www.ioci.org.au

Progress

Willem van Aken

Saltbush plain during drought near Booligal, NSW.

APSIM computer model, help farmers make important decisions that enable them to make the most of both good and bad seasons in a highly variable climate in north-eastern Australia and, now, elsewhere. Initially sceptical, hundred of farmers of cotton, cereals, mungbean, chickpea and sown pastures and many commercial advisory consultants are now converts.

Growers have found that by paying close attention to soil moisture content and nitrogen levels in their paddocks, to climate forecasts, and to other factors, they – with the assistance of the interactive computer models – can assess various options (such as planting times, whether to plant a crop at all, or fertilisation rates) and make really well-informed decisions that optimise farm productivity, despite a notoriously variable Australian environment.

Running an APSIM simulation before making management decisions can save farmers significant amounts of money. Mr Peter Van Beek, a consultant who evaluated use of soil characterisation and APSIM in regional Western Australia, reported that many farmers saw its potential to 'avoid huge financial losses during dry years'. Farmers see it as a tool for risk management.

As one farmer told Van Beek, 'We used to go on a wing and a prayer, but now, if I don't have the (soil) moisture, I won't put in a crop.'

FARMSCAPE has helped participants make the connection between El Niño, soil moisture, crop or pasture growth, sound decision-making and farm productivity and profitability. For example, if there is not enough water stored in the soil profile, it is probably risky to sow. Opting for a fallow to allow soil moisture to build up for, say, a summer crop instead is sometimes a better decision – the computer model can help by showing the likely consequences of various scenarios.

'In great demand, the APSIM software package is now commercially available through four companies that are trained and accredited to deliver the FARMSCAPE technology and we are currently in the process of setting up an online commercial delivery service so that growers can access climate-risk management information by the internet,' says Carberry. 'We're doing this online project, called Yield Prophet, in partnership with the Birchip Cropping Group and this year we are taking on a hundred growers nationwide.'

Policy, poverty and politics

Dr Linda Botterill, of the National Europe Centre at the ANU, says that unfortunately drought policy by its very nature is only of periodic interest to the general public and to the media, unlike say interest rate policy. She points out that strong tensions arise between sensible drought policy and the intense political pressures during periods of severe drought.

So although recent developments in drought policy have quite rightly attempted to adopt the idea that drought is a normal feature of the Australian environment – a 'part of the farmer's normal operating environment' to be managed like any other business risk, governments and their advisers have shifted ground on this.

'Because a distinction is made between so-called "normal" droughts and more severe ones, for which the best manager can't be expected to prepare, there is an incentive for farmers to focus on demonstrating that they are experiencing a rare and severe event rather than focusing on risk management, self-reliance and long-

The messages on climate

What do our world-class climatologists reckon, in a nutshell, we have learned about climate change? Mr Kevin Hennessy and Dr Ian Smith, of CSIRO Atmospheric Research, speaking on behalf of many colleagues in Australia, offer some take-home messages on drought.

'Firstly, we know that global warming is real,' says Hennessy. 'Australia has warmed 0.7°C since 1900, mostly after 1950. And due to increasing greenhouse gases, it will continue to get warmer, up 0.4 to 2.0°C by 2030. That isn't so far off. In the last decade, we have witnessed the highest mean annual temperatures since records began and droughts have definitely become hotter since 1973.

He adds that considering the projected changes in rainfall – likely to decrease in the south-west and in parts of the south-east and Queensland – and increases in temperature and potential evaporation, droughts will probably continue to intensify.

Smith says that while Australian rainfall has already increased in the north-west, it has also decreased in the more populated south-west and south-eastern coastal regions since 1950. These drying trends in the south of Australia, already the driest inhabited continent, could be due to a combination of increasing CO_2 and other greenhouse gases, natural variability and possibly ozone depletion.

An uncomfortable combination of future reductions in stream flow and water supply and increases in water demand will no doubt intensify competition for dwindling water resources, between irrigators, industries, cities and environmental flows. In the face of worsening drought over much of Australia, we need to be adaptable and allow for climate change in our water resource planning. To date, the consequences of a changing climate have not been seriously injected into the water policy debate.

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Hand-feeding of livestock during drought is expensive but could become a more frequent occurrence in southern Australia with climate change.

term profitability,' says Botterill. 'Government decisions have also blurred the message – for example, the introduction of the Drought Relief Payment in 1994 softened the previous hardline approach by making welfare available to *all* farmers in an area declared to be in exceptional circumstances, regardless of their business viability.'

Similar deviations from the economic line due to political pressure from the media (such as the Farm Hand Appeals which gave the impression that governments weren't doing enough) were apparent in the 1990s and in the 2002–2003 drought. 'Politicians' hard-headed references to drought as a normal business risk have been replaced by statements that the 2002 drought is "the cruellest drought of all" and the like. The drought is personified and farmers are implicitly the victims,' says Botterill.

In fact, she says, in contrast to the 1990s drought, the recent drought followed a run of good years, good prices and low interest rates. She says while farmers, politicians and journalists almost inevitably react emotionally to drought, policy makers (and Botterill used to be one) must calmly tackle the task of developing sound and equitable programs that respond to real need, not political pressure.

So what is the way forward for policy?

'Firstly, the whole question of drought declarations is problematic,' says Botterill. 'Linking government support to declarations raises thorny matters relating to definitions, eligibility and lines on maps and often leads to politicisation of the issue. A support mechanism for farmers based on individual need rather than specific events – such as HECS-type income-related loans – would help solve this problem.'

Farm poverty also needs further examination. Improving farmers' access to welfare support would help to address this concern. Recent handling of farmer welfare issues as part of structural adjustment policy has resulted in a series of policies with a primary objective of industry adjustment rather than alleviating poverty caused by drought and other factors.

Botterill concludes that: 'With established policies to respond to the needs of farm businesses and farm families in difficulty, governments could decouple support from specific events and respond to individual situations. Until this happens, the highly politicised and ad hoc approach to drought is likely to continue, at great cost to the taxpayer and at the risk of entrenching real inequities between farmers, and between farmers and the rest of the community.'

More information:

Botterill, LC and Fisher, M (eds). (2003). *Beyond Drought: People, Policy and Perspectives*. CSIRO Publishing: Collingwood.

Pittock, B (ed). (2003). *Climate Change: An Australian Guide to the Science and Potential Impacts*, Australian Greenhouse Office: Canberra.

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CSIRO: Climate change projections and impacts for Australia. http://www.dar.csiro.au/impacts/future.html

Climate Risk Technologies

If any country needs a Cooperative Research Centre (CRC) for dealing with climate variability it is Australia, so the recent success of a proposal for a CRC for Climate Risk Technologies, in passing the first round of applications, is good news.

Australia is already a world leader in climate research and the CRC aims to build this capacity and convert the science into practical and effective management strategies to deal with the risk of climate change and extremes, including drought. It will influence how we relate to our unique and highly variable climate, helping industries and communities to cope with bad years or seasons and make the most of good times.

Dr Roger Stone, senior climatologist with the Queensland Department of Primary Industries and a principal driving force behind the proposal, says the CRC will have a strong commercial focus and has generated much interest. It already has a commercial sponsor, Suncorp Metway, along with, to date, Meat & Livestock Australia and DPI Forestry. If the CRC is established, hopefully in 2005, sectors

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which would benefit include: agriculture, forestry, water, energy, natural resource management, ecosystems like rangelands, lending, insurance, emergency management and tourism.

'Dealing with climate variability should be a normal part of business here,' says Stone. 'Take grain trading. Climate vicissitude – good and bad seasons – has a tremendous effect. Better climate forecasting and risk management would be a real benefit. Similarly, the CRC could develop a workable financial management system for water trading if required.'

'The scope for innovative, creative and profitable research, education and commercialisation in the area of climate risk management is almost boundless and the need is great … but first we need to get over the next hurdle … the second round of CRC applications,' says Stone.

More information:
www.crcclimaterisk.org.au