Managing for a variable climate: preparing for climate change

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Abstract
When discussing climate risk, it is important to think through how climate variability and climate change interact. This paper discusses the uncertainty in climate change and the evidence for its impact on Australia. Although exposed and sensitive to climate, the ability of graziers to manage variability suggests that they have a high degree of adaptive capacity. Also, information is now more freely available to assist them meet future challenges.

Key words
Climate variability, climate change, adaptation.

Introduction

The theme for this conference is managing for a variable climate. Climate variability usually refers to season-to-season variability that has long been discussed in Australian agriculture. In recent years the term climate change has had enormous attention in the media, politics and also amongst farmers. Geologists use the term climate change to refer to major shifts in climate that can be seen in ocean sediments, tree rings and ice cores. The current use of the term 'climate change' commonly refers to human-induced changes to climate, due largely to burning of fossil fuels enhancing the greenhouse effect. Of course, there are many other ways that humans can change climate in a location by pollution, modifying the ozone layer, land-use change and contributing other greenhouse gases such as methane and nitrous oxide. There is ample discussion of the basic science of climate change at (http://www.greenhouse.gov.au/science). The Intergovernmental Panel on Climate Change Summary for Policy Makers (IPCC 2007) is a concise document that gives an overview of the latest science.

Climate has always varied on all time scales and Australian farmers have managed a more highly variable climate than most other regions of the world. After difficult seasons like 2006, older and wiser heads are quick to point to tough seasons in the past and, in doing so, they have pretty convincing records and memories. In many cases, when farmers question climate change, they are questioning a view of climate change that seems to deny the year-to-year and decade-to-decade variability. It is important to note that accepting the science of climate change does not require one to discount the importance of year-to-year and decade-to-decade climate variability.

Climate change – from global change to local impacts

Figure 1 can be used as a framework to think about the confidence and uncertainty in climate change science and impacts. The evidence for the vertical arrows is getting stronger. However, the exact impact on regional climates, and then local farming systems, is best represented as cascading uncertainty. The different emission scenarios provide an irreducible uncertainty which is further increased by the way different global circulation models translate an increase in greenhouse gases to global warming. There are further differences from the projections of global circulation models on Australian climate, and then questions of how these multifaceted changes in climate will influence farming systems.

There is more confidence in the projections for temperature (including more heatwaves and fewer frosts), sea level rise and increase in cyclonic wind intensity. There is lower confidence in rainfall, run-off and non-cyclonic severe weather events.

While a warmer world is expected to be a wetter world, southern Australia is expected to be drier. For most of agriculture, this projection is the most worrying, but also the most uncertain aspect of the projections. There was a relatively high level of consistency between global circulation models used for the Intergovernmental Panel on Climate Change

in 2001 (IPCC 2001) on the drying trend in Southern Australia. This consistency is repeated in the latest models used for the Fourth Assessment round of the IPCC report in 2007.

adaptation possible. It is difficult to see how farming could adapt to the more severe end of the warming and drying predictions.

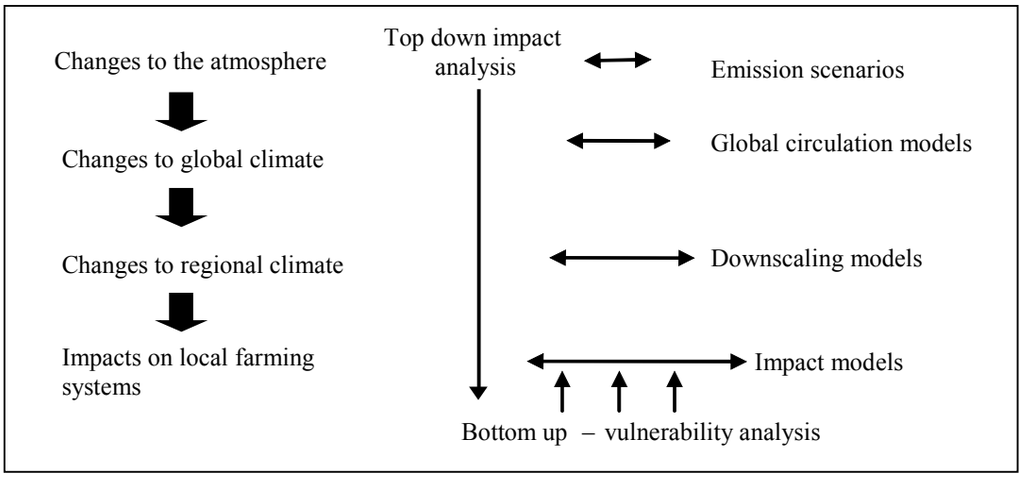

Figure 1. Cascading uncertainty. Adapted from Schneider (2004).

We need to keep working on a top-down approach whereby we access the latest climate modelling from CSIRO for NSW projections (see www.cmar.csiro.au/e-print/open/hennessy_2004b.pdf.) However, there is likely to always be a mismatch between the resolution desired by decision makers and what can be delivered by climate science. A complementary approach is a "bottom up" approach whereby we characterise the vulnerability of different industries to changes in temperature, rainfall and extreme events (Figure 1). By definition, this is a task that needs to include decision makers.

Climate variability and climate change

The relationship between climate variability and change is usefully explained in Figure 2 prepared by Roger Jones of CSIRO (see McInnes *et al.* 2003). The contrast is between variability within a stationary climate, and variability within a changing climate. For any system, such as a farm, there is a degree of variability that can be managed, and this is labelled the coping range. Beyond that range the system is vulnerable. In a changing climate, the damage to a system is most likely to come from the extremes rather than the mean.

Figure 2 also shows that the coping range can be widened with adaptation. For example, more heat-tolerant and water use-efficient pastures and animals will have a wider coping range. In terms of climate change, the extent of the change and the time of the change are important features that will make Figure 2 also shows how the planning horizon is relevant to any discussion of climate change. Climate change is going to feature less in a decision of what to do in the coming year than purchase of land or decisions about whether children come back to the farm.

Evidence for climate change in Australia

Nicholls (2006) reviewed the evidence for climate change in Australian records. He emphasised the importance of the two verbs – to detect a trend and to attribute the cause of the trend. Detection is finding a change and showing that it is something beyond what we might expect by random chance (due to internal, natural climate variability). Attribution is the process of establishing the most likely causes for the detected change – for example human-induced climate change. According to Nicholls' review, detection and attribution studies of Australian climate indicate that:

- The widespread warming is very likely to be due to increased greenhouse gas concentrations.
- The rainfall decrease in southwest Western Australia is likely due to a combination of increased greenhouse gas concentrations, natural climate variability, and land use change.
- The increased summer rainfall in northwest Australia may be due to increased aerosols resulting from human activity, especially in Asia.
- The apparent decline in pan evaporation is mainly due to changes in instrumental exposure.

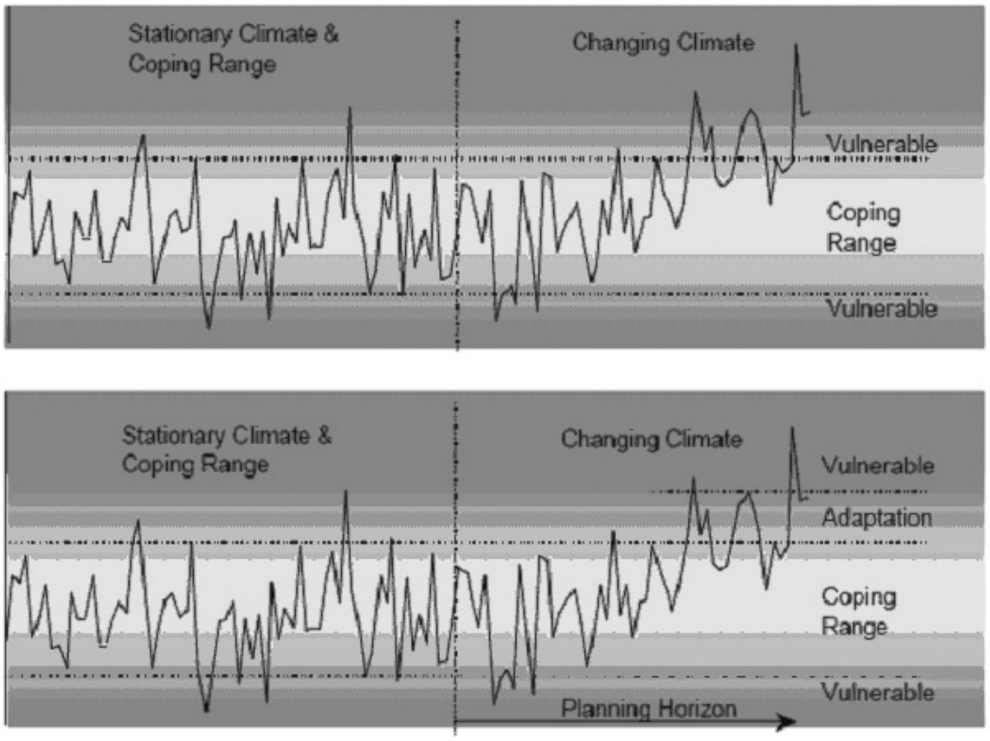

Figure 2. The relationship between climate variability and change (from Roger Jones, CSIRO in McInnes *et al.* 2003).

• No study has attributed a cause to the rainfall decrease along the east coast.

Nicholls suggests that a comprehensive, Australia-wide, formal detection and attribution study to determine how firmly we can conclude that human activity has affected Australian rainfall, is a high priority.

Barrie Hunt, a now retired CSIRO climate scientist made the following comments about the current drought to the Age Newspaper late last year.

"The warming over the past 10 years, you can't explain that. There isn't any great variability from year to year; it's going up and up and up. If it was natural variability you would be having years of below-average temperature." But he said that judging the effects of climate change on rainfall patterns was much more complex. It could take another 20 to 30 years for a clear trend to emerge. Mr Hunt said if people believed the drought was entirely caused by climate change, they might think it was no longer an issue once better rain returned. "So it's very important to feed into the public consciousness the fact that there is a lot of climatic variability going on, with which the greenhouse effect is interacting." Mr Hunt said it appeared likely that south-eastern Australia would become drier, with climate change increasingly responsible.

A significant issue for graziers is the impact of carbon dioxide on pastures. The status of knowledge on the effects of CO_2 on agriculture and forestry in Australia is covered in Steffen and Canadell (2005). More is understood at the leaf and plant level over short time periods than the paddock or ecosystem level, especially when competition for water, light and nutrients is considered. C3 (cool-season) plants are likely to be more responsive to increasing carbon dioxide than C4 (warm-season) plants. However, because C4 plants are generally more tolerant of heat and water stress, the simple notion that climate change will always favour C3 plants must be applied with caution.

Apart from the direct impact on pasture yield and animal performance, there are likely to be surprises in terms of pests, weeds and diseases. Indeed it is possible that this could be the main impact of climate change.

Although the trends in rainfall are not clear, recent CSIRO modelling predicts a future drying trend for much of southern Australia, and there is a relatively high degree of consistency between global circulation models. Careful reading of the report for South Australia (Suppiah *et al.* 2006) indicates the higher confidence in projections of temperature than rainfall. For most regions,

while the warming trend can already be distinguished from the natural variability, the drying trend does not separate from natural variability until 2050.

Concluding remarks

For graziers, one of the challenges of climate change is keeping up with the information. NSW DPI runs workshops where the basic science is explained. At those workshops the emphasis is on managing climate risk, which includes our variable and changing climate.

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