Chapter 2

Future climate for Australia's key agricultural production zones

Introduction

2.1 This chapter discusses one aspect of the inquiry's first term of reference: the scientific evidence available on the likely future climate of Australia's key agricultural production zones. The committee was referred to two main reports in relation to this term of reference: the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report[1] and the joint Commonwealth Scientific and Industrial Research Organisation (CSIRO) – Bureau of Meteorology (BoM) *Climate Change in Australia* report.[2]

2.2 This chapter begins with a brief overview of some factors influencing climate projections. The chapter then goes on to discuss the predictions made in the IPCC Fourth Assessment Report and the CSIRO-BoM *Climate Change in Australia* report (*Climate Change in Australia*) of the likely future climate of Australia's key agricultural production zones. The chapter also discusses the need for further work to downscale climate projections and better communicate projections to those in the agricultural sector.

2.3 The implications of likely future climate on current farm enterprises and possible future industries will be considered in the final report.

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1 The IPCC is a scientific intergovernmental body set up by the World Meteorological Organisation and the United Nations Environment Programme. The IPCC's role is to assess the latest literature relevant to understanding the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. The IPCC's Fourth Assessment Report, comprising four volumes was released in 2007. The full reference for the Synthesis Report, which contains a synthesis of all the findings in the assessment report is: IPCC, 2007: *Climate Change 2007: Synthesis Report. Contributions of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland (*Synthesis Report*). Unless otherwise stated, references to the IPCC's Fourth Assessment Report are to the Synthesis Report.

2 *Climate Change in Australia* complements the IPCC Report detailing regional climate change detail, consistent with the global predictions in the IPCC Report. The full reference for *Climate Change in Australia* is: Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM): *Climate Change in Australia – Technical Report 2007*.

Climate projections

2.4 The complexity of the climate system means that forecasting likely future climate is not simply a matter of extrapolating from past trends. Instead, climate models, which are mathematical representations of the Earth's climate system, are used to forecast weather and climate.[3]

2.5 However, as *Climate Change in Australia* notes projections of global and regional climate change contain a large number of uncertainties.[4]

2.6 The IPCC Fourth Assessment Report states that 'significant factors' contribute to uncertainty in projected climate change for the Australia-New Zealand region. This uncertainty reduces confidence in projections:

> The El Niño-Southern Oscillation significantly influences rainfall, drought and tropical cyclone behaviour in the region and it is uncertain how [the El Niño-Southern Oscillation] will change in the future. Monsoon rainfall simulations and projections vary substantially from model to model, thus we have little confidence in model precipitation projections for northern Australia. More broadly, across the continent summer rainfall projections vary substantially from model to model, reducing confidence in their reliability. In addition, no detailed assessment of [model performance] over Australia or New Zealand is available, which hinders efforts to establish the reliability of projections from these models.[5]

2.7 Human activities also impact on climate through increasing the concentrations of greenhouse gases, such as carbon dioxide and methane, in the Earth's atmosphere. One of the key difficulties in making long-term climate projections, and consequently assessing future climate change, is determining future greenhouse gas emissions due to human activities. This is explained in *Climate Change in Australia*:

> near-term changes in climate are strongly affected by inertia in the climate system due to past greenhouse gas emissions, whereas climate changes later in the century are more dependent on the particular pattern of greenhouse gas emissions that occur through the century.[6]

2.8 In order to overcome this problem the IPCC has developed a range of emissions scenarios.[7] The IPCC describes these scenarios as 'images of the future, or

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3 *Climate Change in Australia*, pp 38-39.

4 *Climate Change in Australia*, p. 44.

5 IPCC, 2007: *Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 898.

6 *Climate Change in Australia*, p. 49.

7 These scenarios are commonly referred to as the 'SRES emissions scenarios' – after the IPCC's Special Report on Emissions Scenarios: IPCC, 2000: *Special Report on Emissions Scenarios*, [Nebojsa Nakicenovic and Rob Swart (Eds.)]. Cambridge University Press, (*SRES Report*) available at http://www.ipcc.ch/ipccreports/sres/emission/index.htm (accessed 1 August 2008).

alternative futures', and emphasises that the scenarios are not predictions or forecasts.[8] Importantly, the scenarios do not include additional climate policies for reducing or mitigating greenhouse gas emissions above current policies.[9] Further, the IPCC does not assign any probability that a particular scenario will occur.[10]

2.9 The scenarios are grouped into four 'storylines':[11]

- The A1 storyline describes a world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies. A1 is divided into three groups that describe alternative directions of technological change: fossil intensive (A1FI), non-fossil energy resources (A1T) and a balance across all sources (A1B).
- Storyline A2 describes a very heterogeneous world with high population growth, slow economic development and slow technological change.
- Storyline B1 describes a convergent world, with the same global population as A1, but with more rapid changes in economic structures toward a service and information economy.
- Storyline B2 describes a world with intermediate population and economic growth, emphasising local solutions to economic, social, and environmental sustainability.

2.10 Dr Mark Howden of CSIRO acknowledged the difficulties that uncertainty in climate change projections could cause for those in the agricultural sector, but believes that this uncertainty should not stop decision-making:

> To some extent there is a bit of irreducible uncertainty associated with this. In terms of climate change, yes, there is uncertainty associated with that, but uncertainty does not stop people making decisions. Uncertainty is just an integral part of making decisions on an everyday basis. It is part of how governments make decisions.[12]

2.11 Ms Nicolette Boele of the Agricultural Alliance for Climate Change indicated to the committee that, while there may be barriers to scientific understanding, what is really missing is the political will to stand behind policies and promote market confidence:

> No question, there would be more money and more focus on the science. But the political will and the political statements around the role that

8 IPCC, 2000: *SRES Report*, Chapter 1, Section 1.2, *What are scenarios?*

9 IPCC, 2000: *SRES Report*, Chapter 1, section 1.3, *Uses and Purposes*.

10 IPCC, 2000: *SRES Report*, Summary for Policy Makers, Box 1.

11 IPCC, 2000: *SRES Report*, Summary for Policy Makers, Box 1.

12 *Committee Hansard*, 30 June 2008, p. 6. See also BoM, *Submission 7*, p. 2.

> science can play is just as important as getting farmers paid to change their land management.[13]

2.12 In contrast, the NSW Irrigators Council argued that the scientific evidence presented offered 'far too wide a range' of impacts upon which to base long term policy.[14]

Future climate projections

2.13 This section of the report outlines the projections for future climate, starting with general global predictions, and then setting out specific predictions for Australia. The information is drawn from the IPCC's Fourth Assessment Report and *Climate Change in Australia*.

2.14 These are not the only climate projections studies relevant to Australia.[15] However, the committee also notes that the IPCC Fourth Assessment Report and *Climate Change in Australia* are regarded as the most comprehensive studies using the most extensive and refined modelling techniques, and so the committee has limited its consideration to these reports.[16]

Global climate

2.15 One of the significant observations in the IPCC's Fourth Assessment Report is that:

> [w]arming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level… [17]

2.16 The IPCC makes the following projections of future changes in climate:

> [f]or the next two decades a warming of about 0.2°C per decade is projected for a range of [emissions scenarios]. Even if the concentrations of all [greenhouse gases] and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Afterwards, temperature projections increasingly depend on specific emissions scenarios…[18]

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13 *Committee Hansard*, 1 July 2008, p. 20. See also Ms Boele, *Committee Hansard*, 1 July 2008, p. 16.

14 *Submission 18*, p. 3.

15 See for example WA Department of Water, *Submission 26*, p. 1; Queensland Government, *Submission 30*, p. 4.

16 See Bureau of Meteorology (BoM), *Submission 7*, p. 2; WA Department of Water, *Submission 26*, p. 1; Queensland Government, *Submission 30*, p. 4.

17 IPCC, 2007: *Synthesis Report*, p. 30.

18 IPCC, 2007: *Synthesis Report*, p. 45.

Australian climate

2.17 *Climate Change in Australia* makes climate projections for the years 2030, 2050 and 2070 for a wide range of climate variables.[19] This section of the report details the projections for temperature, precipitation and drought, and then provides a summary of some of the other climate variables.

Temperature[20]

2.18 Temperature projections for 2030 do not vary much among the emissions scenarios, so the results presented in *Climate Change in Australia* are for a mid-range emissions scenario, the A1B scenario. Those projections were that, compared to 1990:[21]

> for most locations the mean warming is 0.7-0.9ºC in coastal areas and 1-1.2ºC inland. In winter, warming is projected to be a little smaller than in the other seasons, as low as 0.5ºC in the far south. Warming is usually smaller near the coasts than further inland, an exception being in the northwest, where the warming exceeds 1.3ºC in spring. The annual result has a similar pattern to the seasons, with the warming being largest in the interior and the north-west.[22]

2.19 By 2050, the best estimate for annual warming is 1.2°C for the B1 (low emission) scenario to 2.2°C for the A1F1 (high emission) scenario. By 2070 the best estimate of annual warming is 1.8°C for the B1 scenario and around 3.4°C for the A1F1 scenario.[23] The pattern of warming in 2050 and 2070 is similar to the 2030 projections – with less warming in the south and north-east and more inland.

2.20 There is also a projected increase in the frequency of hot days and warm nights, and a decrease in the frequency of frosts.

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19 See *Climate Change in Australia*, Table 5.1, p. 50 for a summary of how projections for each climate variable were made. A set of 23 climate models were used for projections, although not all variables could be modelled. The table also sets out the emissions scenarios that were modelled.

20 See Climate Change in Australia, pp 53-64.

21 Temperature projections were made relative to a baseline period of 1980-1999, referred to as '1990' for convenience. See *Climate Change in Australia*, p. 51.

22 *Climate Change in Australia*, p. 53. A full set of projections for all emissions scenarios is set out in Appendix A of *Climate Change in Australia*.

23 'Best estimate' is based on the 50th percentile, the mid-point of the spread of model results, see *Climate Change in Australia*, Summary Brochure – Observed Changes and Projections, p. 3.

Precipitation[24]

2.21 *Climate Change in Australia* notes that there is a disparity in rainfall projections by the different climate models, and as a result it is not possible to make definitive statements about the direction of precipitation changes.[25] Projections of precipitation changes are presented here as a percentage change relative to the 1990 baseline.

2.22 The best estimate projections of precipitation for 2030 for the A1B emissions scenario were for little change in precipitation in the far north of Australia and decreases of 2-5% elsewhere. In terms of seasonal forecasts:

> [i]n summer and autumn decreases [in precipitation] are smaller and there are slight increases in the east. Decreases of around 5% prevail in winter and spring, particularly in the south-west where they reach 10%. These are still smaller, however, than the decreases that were observed there in previous decades ...[26]

2.23 By 2050, under a low emissions scenario (B1), best estimates of annual precipitation were for little change in the far north grading southwards to a decrease of 5%, relative to the 1990 baseline. Under the high emissions scenario (A1F1), the best estimate is for little change in the far north, grading to a 7.5% decrease in precipitation elsewhere.

2.24 By 2070, the best estimates for a low emissions scenario are similar to those seen in the 2050 high emissions scenario projections. For the high emissions scenario, the projections are for little change in the far north grading to around a 10% decrease in the south-west.

2.25 The seasonal changes in precipitation for 2050 and 2070 follow the same trend as those seen in the 2030 projections, but are larger.

2.26 Some of the other key findings in *Climate Change in Australia* in relation to precipitation are:

- models show an increase in daily precipitation intensity, that is the amount of rain on a rain day, and an increase in the number of dry days;
- snow cover, average snow season lengths and snow depth is likely to decline.

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24 See *Climate Change in Australia*, pp 65-75.

25 *Climate Change in Australia*, p. 65.

26 *Climate Change in Australia*, p. 67.

Drought[27]

2.27 *Climate Change in Australia* projected the changes in 'agricultural drought', meaning a period of extremely low soil moisture. The projections were made only for the low (B1) and high (A1F1) emissions scenarios for the years 2030 and 2070. The results of the projections were summarised as:

> up to 20% more drought-months over most of Australia by 2030, with up to 40% more droughts by 2070 in eastern Australia, and up to 80% more droughts in south-western Australia.[28]

Other climate variables[29]

2.28 As noted above *Climate Change in Australia* sets out projections for a range of climate variables. This section of the report briefly summarises the projections for some of those variables:

- Small decreases in humidity are projected over most of Australia, with largest decreases in the south and west, and little change along the east coast and in Tasmania.[30]
- Annual potential evapotranspiration is projected to increase over Australia, with the largest increases being in the north and east.
- In south-eastern Australia there is a substantial increase in fire weather risk likely at most sites.[31]
- There is the potential for significant increases in inundations from storm surges, resulting in flooding and erosion, due to higher mean sea level and more intense weather systems.
- Studies indicate a likely increase in the proportion of tropical cyclones in the more intense categories, but a possible decrease in the total number of cyclones.
- There are indications that hail risk may increase over the south-east coast of Australia.

Utility of climate projections

2.29 During the course of the inquiry, the committee received evidence and submissions relating to the utility of the projections of future climate for the

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27 See *Climate Change in Australia*, pp 83-84.

28 *Climate Change in Australia*, p. 83.

29 This information was drawn directly from *Climate Change in Australia*, Summary Brochure – Observed Changes and Projections, pp 11-12.

30 See also, *Climate Change in Australia*, p. 78.

31 This risk may also exist elsewhere in Australia, but was not examined in *Climate Change in Australia*, see pp. 90-91.

agricultural sector. Of particular importance was the need for a downscaling of projections to a regional level. A further issue raised with the committee was the communication of climate projections in a manner that is meaningful to farmers and others in the agricultural sector. These issues are discussed below.

Downscaling of projections

2.30 Throughout the inquiry the committee was told of the need to downscale climate projections in terms of time and space.[32]

2.31 Apple and Pear Limited stated that the climate models were better at capturing the 'broad-global scale' than the more localised national or regional scale.[33] Growcom highlighted the need for accurate, downscaled climate projections to the horticultural sector:

> [f]or the industry to effectively respond to climate challenges, accurate and detailed information on regional-scale climate changes and how they will affect production and marketing is required. This information is critical to inform the development of management strategies at enterprise, regional and industry scales to effectively manage future climate change impacts.[34]

2.32 Dr Beverly Henry, of Meat and Livestock Australia, indicated that downscaling climate projections was only part of the issue:

> The issues for us, though, are how we get downscaled projections from those models at a scale that we can give to farmers to make decisions. We have to get the regional scale outlooks on the same time frame that farmers make decisions on, but then link them also to the biophysical-type models that will tell us what the impacts will be on pasture growth and on animal production. So there are two steps to do with getting better projections: the regional scale models and then the linking to the impacts at farm level.[35]

2.33 Dr Michael Robinson, of Land and Water Australia, also noted the desire in the agricultural sector for better climate projections on a finer scale with greater certainty.[36]

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32 See for example: Rural Business Development Corporation, *Submission 15*, p. 1; Queensland Government, *Submission 30*, p. 4.

33 *Submission 23*, p. 3.

34 *Submission 31*, p. 10.

35 Dr Beverly Henry, Manager Environment, Sustainability and Climate Change, Meat and Livestock Australia, *Committee Hansard*, 1 July 2008, p. 3.

36 Dr Michael Robinson, Executive Director, Land and Water Australia; and Chair, Joint Strategy Team, National Climate Change Research Strategy for Primary Industries, *Committee Hansard*, 30 June 2008, p. 57.

2.34 *Climate Change in Australia* stated that while climate models are continuing to improve, confidence in climate model projections varies with spatial and temporal scale:

> [h]ighest confidence is attached to results analysed at the coarsest spatial and temporal scales, such as global or hemispheric annual means, and decreases with finer scales, such as sub-continental or regional daily variability. This is partly because the magnitude of natural variability increases as scales decrease, so that regional climate change signals are more easily masked by climate variability. Furthermore, local influences on climate (such as regional topography or processes) become more important at finer spatial scales.[37]

2.35 BoM's submission indicated that the development of improved climate models is an area of research priority in its organisation:

> … continued research and improvements of climate models and in methods used to produce projections are essential. In late 2006 senior researchers from the Bureau of Meteorology and CSIRO defined Australia's climate change knowledge gaps and research priorities. Of particular note was the need to improve the simulations of the earth's climate system by advancing to new generation climate models, which not only contain the physics of the atmosphere, oceans and cryosphere (as done in earlier generation models), but also the physics and/or chemistry of interrelated aspects such as the biosphere and radiatively active gases. Such improvements would also include a full carbon cycle, covering the terrestrial (including full vegetation model), ocean and atmosphere systems.[38]

Communication

2.36 The committee's attention was also drawn to the need to communicate climate projections in a manner that assists farmers in their decisions making.

2.37 The Primary Industries & Natural Resources Curriculum Centre, TAFE NSW, believes that existing scientific evidence is not readily available to the population generally and recommended that all available data be presented in Plain English, which should be easily understood.[39]

2.38 The Australian Landcare Council called for:

> regional, national and international communication of scientific information about climate change, that is all inclusive, meaningful and useful.[40]

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37 *Climate Change in Australia*, p. 41.

38 *Submission 7*, p. 5. The National Farmers Federation has also identified the research and development of more accurate climate models as a primary focus, see *Submission 24*, p. 6.

39 *Submission 4*, p. 1.

40 *Submission 13*, p. 3.

2.39 In evidence to the committee Ms Nicolette Boele, representing the Agricultural Alliance on Climate Change, highlighted the difficulty of choosing the best means to communicate with those in the agricultural sector:

> We have done a little bit of research on how to communicate climate science to the agricultural sector and the regional and rural communities that support it. We did find that generally farm sizes are getting larger and that the population is ageing, which raises a whole lot of questions about which medium you can reach the sector with.
>
> …These people are very busy; they are running businesses. It is only really the big end of town that has the time, resources and intentions to go and actively find more data about climate change and what it might do for their businesses
>
> … it is probably the content and quality of the data but also how that extension happens, how you actually make climate information not an added thing but included in existing paths of communication for those people.[41]

2.40 Ms Boele was also supportive of using those who were well-respected in the farming industry as communicators of scientific information:

> …this is a particular community that really listens to its peers. Instead of having CSIRO type science communicators talking at, down and across to farmers, if you can actually somehow have champions within communities that are esteemed by their peers, that is going to go a hell of a lot faster.[42]

2.41 BoM set out in its submission some of the programs it has in place for communicating climate information, including:[43]

- the seasonal outlook service for rainfall and temperature;
- commentary on the state of the El Niño-Southern Oscillation; and
- the Water and Land website providing meteorological information specifically tailored for primary industry and natural resource management.

Committee view

2.42 The evidence before the committee is that there is general acceptance by those in the agricultural sector that climate change is occurring.[44]

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41 *Committee Hansard*, 1 July 2008, pp 24-25.

42 *Committee Hansard*, 1 July 2008, p. 25. See also Dr Mark Howden, Theme Leader, Climate Adaptation Flagship, CSIRO, *Committee Hansard*, 30 June 2008, p. 17 who noted the usefulness of organisations such as Landcare for communicating information to farmers.

43 *Submission 7*, pp 5-6.

2.43 The changes in climate projected in the IPCC's Fourth Report and *Climate Change in Australia* would have significant impacts on the Australian agricultural sector, and these impacts will be discussed in the committee's final report. However, the committee is concerned that climate projections may be underestimating the amount of warming which may occur in future:

> There is a significant possibility that warming may occur in excess of these values, particularly later in the century, although the likelihood of this occurrence is impossible to estimate at this stage.[45]

2.44 The committee appreciates that significant work has, and continues, to occur on producing long-term climate projections on a global and national scale. The committee recognises the need for more work to be done to downscale climate change projections to a local level to be of greater use to farmers in decision-making. The committee notes that there is already work in progress on improving and downscaling climate models and projections.[46]

2.45 The committee believes that there is an urgent need for improved communication of climate projections to farmers and others in the agricultural sector. The committee understands the uncertainties and limitations inherent in climate projections cause frustration for those in the agricultural sector trying to plan for a changing future climate. It is the committee's view that better communication of climate projections is required in order for this information to be of use to farmers and others in the agricultural sector. The committee encourages CSIRO, BoM and other research groups involved in climate projections to give consideration to the manner and mode in which climate projections are presented to the agricultural sector.

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44 See for example: Gwydir Valley Irrigators Association Inc, *Submission 14*, p. 1; Apple and Pear Limited, *Submission 23*, p. 1; Growcom, *Submission 31*, p. 8; Mr Tim Wiley, *Committee Hansard*, 30 June 2008, p. 39; Mr Ben Faragher, Chief Executive Officer, National Farmers Federation, *Committee Hansard*, 1 July 2008, p. 26.

45 BoM, *Submission 7*, p. 4, quoting from *Climate Change in Australia*.

46 See for example Mr Jason Alexandra, Director, Water Policy Coordination, Murray-Darling Basin Commission, *Committee Hansard*, 30 June 2008, p. 67; Queensland Government, *Submission 30*, p. 4; Growcom, *Submission 31*, p. 8.