

## Climate change adaptation, risk management and education to meet needs in rangelands

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We adhere to the following principles:

- The science of climate change is well developed and understood, yet still evolving. This has allowed scientists at the same time to make definitive statements supported by scientific evidence. Their three pre-eminent claims are:
  - Warming trends are supported by data sets locally, nationally, and internationally. This is not part of a short-term cycle, but a trend (IPCC 2013);
  - The trending increase in temperature is caused by increasing greenhouse gases (GHG) [carbon dioxide, methane, nitrous oxide, ozone, water vapor] concentrations in the atmosphere during the past 150 years (IPCC 2013);
  - Atmospheric chemistry, climate and GHG breakdown rates are interrelated and lagged, thereby leading to an increasing temperature momentum in our climate system; and even if GHG emissions are reduced or cut immediately, the warming trend will prevail for the foreseeable future (IPCC 2014a,b)
- The best graziers manage current seasonal climate variability, defined by within season variability and short-term season to following season variability reasonably well, and apply best management practices to minimise risks in sustaining production. Those same graziers are on the whole considerate of climate change, but evidence is not obvious there is overwhelming support to build the will or the skill, in concert with the time-frame in which to apply well considered best management practices to adapt to or mitigate against climate change - that properly integrates the financial cost, the expectation of reliability of production, and the impacts on vulnerable natural resources (Lloyd et al. 2008; George et al. 2016; Lloyd and George 2016; Selby 2007). Mitigating against and adapting to the complexity of climate change in primary industries is not easy as long-term management decision making is, without assistance, beyond the scope of most, owing to, but not exclusive to: a pressing need to manage for the immediate and not the future; financial constraints; and, a need for leadership and support.
- Because climate variability already creates a major challenge for agriculture in Australia, and since climate change ratchets up even more risky climate variability, creating extremes, adaptation to and mitigation against climate change is essential and not optional. An example of transformative adaptation in other agricultural enterprises already exists. Processes must include strategic planning, risk management, and education and extension, at both the farm and national level (IPCC 2014a,b). There must be authentic consultation processes and concurrences of action involving farm managers, scientists, government and industry, in establishing ways forward.
- An endorsed method (George et al. 2007a), and accredited climate education approach (George et al. 2007b) involves:
  - Surveying climate and enterprise data (including natural resources);
  - Analysing climate risk and opportunities; and
  - Developing climate risk management strategies.

- Governments should be urged to identify that any barriers or inability to adopt best climate change mitigation and adaptation practices, will come at a cost to agricultural production, to current satisfactory socio-economic standards, and to the environment. As a consequence, this requires a positive and immediate response with urgent investment in education and extension processes as standard components of the relief packages that are provided. Business as usual, or 'no action,' or maladaptation are contrary to the best interests of Australian agriculture and natural resources (Garnaut 2008, 2011).

### Further reading

- Garnaut, R. (2008). The Garnaut Climate Change Review: Final Report. Melbourne, Australia: Commonwealth of Australia, Cambridge University Press.
- Garnaut, R. (2011). The Garnaut Review 2011: Australia in the Global Response to Climate Change. Melbourne, Australia: Cambridge University Press
- George, D.A., Clewett, J.F., Lloyd, D.L., McKellar, R., Tan, P.L., Howden, S.M., Ugalde, D., Rickards, L. and Barlow, E.W.R. (2019). Research priorities and best practices for managing climate risk and climate change adaptation in Australian agriculture. *Australasian Journal of Environmental Management*. 26(1), 6-24. <https://doi.org/10.1080/14486563.2018.1506948>
- George, D.A., Birch, C., Clewett, J.F., Wright A., Allen, W. and Keogh, D.U. (2007a). Needs for applied climate education in agriculture. *Australian Journal of Experimental Agriculture*. 47(1), 1-12.
- George, D.A., Clewett, J.F., Birch, C., Wright A. and Allen, W. (2007b). Development and accreditation of an applied climate education unit for sustainable land use in Australia. *Journal of Sustainable Agriculture*. 29(4), 87-108.
- IPCC AR5 WG1 (2013), Stocker, T.F.; et al. (eds.), [Climate Change 2013: The Physical Science Basis. Working Group 1 \(WG1\) Contribution to the Intergovernmental Panel on Climate Change \(IPCC\) 5th Assessment Report \(AR5\)](#), Cambridge University Press.
- IPCC AR5 WG2 A (2014a), Field, C.B.; et al. (eds.), [Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II \(WG2\) to the Fifth Assessment Report \(AR5\) of the Intergovernmental Panel on Climate Change \(IPCC\)](#), Cambridge University Press.
- IPCC AR5 WG3 (2014b), Edenhofer, O.; et al. (eds.), [Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III \(WG3\) to the Fifth Assessment Report \(AR5\) of the Intergovernmental Panel on Climate Change \(IPCC\)](#), Cambridge University Press.
- Lloyd, D.L. and George, D.A. (2016) Thoughts on accelerating innovation and adoption in Australian agriculture. *Agricultural Science Journal*. 28(1), 26-29.
- Lloyd, D.L., George, D.A., Carberry, P., Birch, C., Midmore, D., Routley, R., Stuckey, S. and Hamblin, R. (eds.) (2008). *Challenges and opportunities for agriculture in a changing Carbon economy*. AIAST, Queensland Division Annual Conference, 3 September, 2008. Marriott Hotel, Brisbane.
- Selby, D. (2007). As the heating happens: education for sustainable development or education for sustainable contraction? *International Journal of Innovation and Sustainable Development*, 2(3/4), 249-267.