

# A Rangelands Conundrum – the Division Within and Among Producers and Stakeholders Regarding Climate Change: Addressing the Challenge to Promote and Gain Consensus of Perception

David L. Lloyd OAM<sup>1</sup> and David A. George<sup>2</sup>

## Abstract

The science of climate change is almost universally accepted by the science community, yet producers and other key stakeholders in the rangelands are divided in their beliefs and understandings of climate change and the part that climate change plays in extreme events that impact their businesses. To counteract that, this article suggests that emphasis on sound, educationally framed climate information will arm producers and stakeholders with leading-edge knowledge and techniques to meet the challenges of rapidly reducing their emissions and building resilience. They will require skills, knowledge, leadership and resources to adapt to a new reality. It is suggested that collaborative and innovative strategies are needed. Extension programs that are active, results-oriented and collaborative, such as those between multiple stakeholders, government and research institutes, are necessary. Inaction should not be justified through past mistakes, which must not be repeated. Authentic evaluation examining end-results and practice change are essential. This article identifies a series of strategies for future engagement with producers, and discusses resistance to change. Various methods for collecting support from producers and stakeholders are considered. It is concluded that incentives and the ways in which knowledge is transferred must be sufficiently robust so that political, industrial and/or ideological sabotage is resisted. This would represent an irreversible, changed approach to rangelands management, use and sustainment.

**Keywords:** climate change adaptation, risk management, belief systems, scepticism, action learning process

<sup>1</sup> School of Agriculture and Food Sciences, The University of Queensland, St Lucia, QLD 4072, Australia ([david.lloyd@uq.edu.au](mailto:david.lloyd@uq.edu.au))

<sup>2</sup> Australian Rivers Institute, Griffith University, Nathan, QLD 4111, Australia ([d.george@griffith.edu.au](mailto:d.george@griffith.edu.au))

Lloyd, D. L., & George, D. A. (2022). A rangelands conundrum – the division within and among producers and stakeholders regarding climate change: Addressing the challenge to promote and gain consensus of perception. *Proceedings of The Royal Society of Queensland*, 131, 71–85. <https://doi.org/10.53060/prsq.2022-05>

## Introduction

There is an underpinning need for all stakeholders in the rangelands to adopt best practices in adapting to a warming climate. The process chain for all products from our rangelands must continually evolve to remain competitive, relevant and sustainable in a rapidly changing world. Markets

will demand low carbon product. Government and society are beginning to demand good corporate and industry citizenship, and land stewardship, and this is likely to intensify whilst nature does, and will, make conditions more challenging.

The science of climate change and its effects on the environment have been almost universally

This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International Licence. Individual articles may be copied or downloaded for private, scholarly and not-for-profit use. Quotations may be extracted provided that the author and The Royal Society of Queensland are acknowledged. Queries regarding republication of papers, or parts of papers such as figures and photographs, should be addressed to the Secretary of The Royal Society of Queensland ([rsocqld@gmail.com](mailto:rsocqld@gmail.com)).

accepted by the scientific community (Anderegg et al., 2010). Local and global warming trends are supported by datasets locally, nationally and internationally (Bureau of Meteorology (BoM), 2018, 2019, 2020; Intergovernmental Panel on Climate Change (IPCC), 2021). The warming process is not part of a short-term cycle, but a trend that will prevail for the foreseeable future (Food and Agriculture Organization of the United Nations (FAO), 2013). Yet, there is a difference of opinion, a conundrum, with climate change sceptics and deniers influencing both the development of policy and many people in the community generally (Boycoff, 2013; Crowley, 2021; Mooney, 2005; Sattler, 2020).

A dichotomy of opinion on the significance of climate change was emphasised during the Rangelands Dialogue, a 2019 conference presented by The Royal Society of Queensland, at which only one paper specifically addressed that subject (Lloyd et al., 2020), among the 25 independent papers that were published (Sattler, 2020). A division of opinion was reinforced by subsequent email discussions in a monitored feedback process among participants (including pastoralists, scientists, economists and consultants). The feedback responses emphasised disagreement in both belief in climate change and the importance of addressing its implications for rangeland management.

The rangelands, expressly the extensive grazing systems of the semi-arid, low-rainfall grasslands and woodlands, and the savannah woodlands of northern Australia, are “stressed” (Hoban, 2020) and in poor and deteriorating condition (Briggs, 2020), with the natural resource base now further challenged by the effects of climate change. Extension aims to apply and accelerate adoption of best management practices in the rangelands, particularly pertaining to grazing management, pasture management and sustainable land use, in the face of climatic challenges. Notwithstanding the developments in climate science, the process to deliver education and extension, addressing such issues where confounding messages abound, is also gaining prominence (Bawden et al., 1984; Bawden, 2010). Can psychology help address this issue? Bawden et al. (1984) considered a systems approach most useful in enhancing problem solving and learning because it was superior to reductionist, discipline-based approaches. There are now more elegant methods for overcoming underlying

psychological beliefs without manipulation (Ecker et al., 2022; Vraga & Bode, 2017; Vraga et al., 2020).

This article, a reference-based review, describes opposing beliefs of stakeholders in terms, on one hand, of the science itself and the practices needed to adapt to and mitigate climate change, and, on the other, of the views and influences of the sceptics (Maslin, 2019). It describes better processes that are being adopted and proposes focused techniques to apply to adult learning methodologies. These are needed to build capacity, to create positive informed debate, to influence attitudinal change and leadership, and to implement positive action (Davis, 2009; Hine et al., 2013; Knowles, 1975; Lloyd & George, 2008; Monroe, 2015; Reser et al., 2012). Although this article targets Australia’s northern rangelands specifically as the catalyst in this discussion, the principles espoused are relevant in any other primary industry sector.

### **What Is the Fundamental Science Around Climate Change and What Are the Important Underpinning Elements?**

A trending increase in temperature is caused by increasing greenhouse gas (GHG) [carbon dioxide, methane, nitrous oxide, ozone, water vapor] concentrations in the atmosphere, particularly during the past 150 years. The concentration of carbon dioxide, for example, ranged between 172 and 300 ppm up to the year 1750 (the conventional benchmark of the pre- and post-industrial era), to rise to more than 410 ppm by October 2020 (Arrhenius, 1896; Denning, 2021; Intergovernmental Panel on Climate Change (IPCC), 2001, 2013, 2014, 2021; National Aeronautics and Space Administration (NASA), 2021).

Throughout Australia, the average mean temperature between 2011 and 2020 was 0.77°C above the average, with a 0.9°C warming since the year 1970 (Bureau of Meteorology (BoM), 2018, 2019, 2020). In 2020 a national warming of 1.15°C above the annual mean temperature was recorded (Bureau of Meteorology (BoM), 2020). To emphasise the climatic extremes experienced during the past decade, 2019 was Australia’s warmest year on record, with the national annual mean temperature 1.52°C above average and the mean maximum 2.09°C above average. It was also the driest year on record, with the nationally averaged rainfall 40% below average (277.6 mm) and much of Australia

affected by drought (Bureau of Meteorology (BoM), 2020). This created widespread, extreme fire weather conditions.

Trending temperature increases cannot be dismissed as ‘normally occurring’ variability when there is a permanent move to a higher, most frequent value on the normal curve of ‘average’ temperature distribution. This provides clear evidence of the occurrence of a warming future (Figure 1). Since 1951, the warming recorded has had the effect of shifting the bell curve towards higher temperatures, and the higher ‘extremes’ happen more often (NASA, 2021, citing IPCC 2001 data). The warming measured will increase the probabilities of occurrence of extreme events that include both prolonged droughts and torrential rains (Thomas et al., 2007). This is the alarm bell for agriculture, as such extremes will decrease the reliability of production and threaten the yields of food, fibre, forestry, fisheries and pharmaceuticals (AgForce, 2017; Ag Institute Australia (AIA), 2018; Barlow et al., 2011, 2013; Luke & Macarthur, 1986; McKeon et al., 1988, 2004; National Farmers Federation (NFF), 2015; Queensland Government, 2013; Recher et al., 1990).

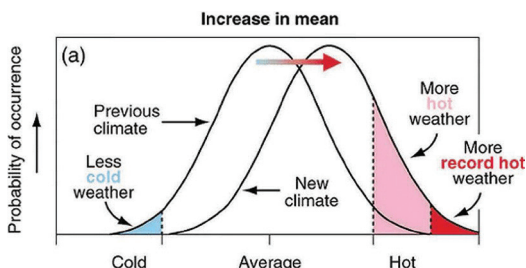


FIGURE 1. The changing schematic bell curve – from ‘present’ to ‘future’ of ‘average’ temperature – given a changing climate (Source: Data from Intergovernmental Panel on Climate Change (IPCC), 2001; modified from image reproduced by Naughten, 2012; accessed 2 June 2022).

Global changes in temperature and rainfall ascribed to ‘climate change’ are inexorably linked to the health of ecosystems, to sustainable agricultural productivity and to a secure food chain. In agricultural industries outside the rangelands, such extremes have had calamitous effects (for example, in the 2007–2008 southern hemisphere summer,

there was a 98% failure of the Australian rice crop owing to the effects of low rainfall [drought] and low streamflow discharge). Rangelands are also susceptible to such climatically extreme events (Garnaut, 2008, 2011; Hacker & McDonald, 2021; Lloyd & George, 2008; McKeon et al., 1988, 2004; Stern, 2007; Stokes & Howden, 2010; World Commission on Environment and Development (WCED), 1987).

Climate change will initiate extreme events such as the sudden onset of direct and indirect climate disasters, and new vectors for human, plant and livestock pests and diseases. Such impacts occurring at ‘local’ level, particularly in the form of droughts and floods, cause severe hardship (Davis, 2009; Grains Research and Development Corporation (GRDC), 2009, 2015). The abilities of graziers to deal with different forms of risk, as well as changes to their frequency, severity and duration that exceed the historical experiences and risks associated with seasonal climate variability, will become ever more crucial and will demand a greater focus on education and implementation processes concerning climate and risk (Farmers for Climate Action, 2021; George et al., 2019; George, 2020; Hacker & McDonald, 2021).

### What Are Relevant Adaptation and Mitigation Practices?

To address the influences of climate change on climate variability, the implementation of existing and more recently proposed, incremental and transformative adaptation measures is needed. These measures have been referred to as ‘no regrets’ and ‘climate justified’, respectively (George et al., 2019). Additionally, mitigation processes that reduce or capture GHGs to lessen the extent and severity of climate change and its effects must be applied and/or accelerated (Food and Agriculture Organization of the United Nations (FAO), 2013; Stokes & Howden, 2010).

Practices suited to managing both climate variability and climate change (‘no regrets’ actions) are practices that are already commonly used to manage our variable climate, and include (George et al., 2019):

- maximising pasture growth by best management practice;

- matching stocking rate to pasture growth using sustainable, risk-averse levels of pasture utilisation;
- building knowledge and skills to achieve best management practices;
- developing comprehensive plans for managing drought, flood, heatwave and fire risk;
- achieving sustainable and profitable land management that improves soil conservation, soil health, and water conservation and water use efficiencies through on-farm infrastructure and good soil management practices;
- monitoring and ensuring water quality and quantity;
- providing animal health feed supplements;
- establishing or improving shelter/shade-belts and considering agro-forestry/soil carbon capture; and
- evaluating and implementing income options for increased on-farm carbon sequestration and energy production (including diversified and new technological alternative actions such as embracing solar and wind energy generation).

Practices proposed for managing the increased risks from climate change ('climate justified' actions) are implemented as incremental and transformative measures for better managing climate change, and could include (George et al., 2019):

- selecting livestock with greater thermoregulatory control and tolerance to heat stress;
- developing and using crop and pasture cultivars with greater heat, pest and disease tolerances, and that are better suited to projected temperature and rainfall changes;
- livestock management methodologies that help mitigate GHG emissions;
- assessing the effects of climate change risks ('likelihood' multiplied by 'impact') as part of risk management processes;
- further developing and evaluating best management practices to manage the complexities and uncertainties of climate change;
- increasing safety margins on flood-prone structures and establishing animal refuges to cater for more extreme rainfall events;
- increasing property and business diversification and planning that manages for extreme weather events;

- considering the costs and benefits of increasing security on water supplies;
- increasing investment in emergency services such as fire-fighting facilities and capacity to respond to increasing bushfire risk;
- diversifying a portfolio of income, including carbon farming; and
- assessing how and when to implement transformational change or planned 'retreat'.

Many of these practices are not new (Food and Agriculture Organization of the United Nations (FAO), 2013; Stokes & Howden, 2010), yet, notwithstanding some level of ongoing extension, adoption has been generally disappointing (Briggs, 2020; George et al., 2019; Hoban, 2020; McKeon et al., 2004). Other factors, too, have been responsible for a less-than-widespread uptake. For example, where income is relatively low and the cost of adopting and implementing expensive risk management measures is high and incentives are not provided, positive action is difficult (Anon., 2011). Furthermore, climate change adaptation practices are complex, and unique to individual operations and enterprises. A single strategy response is likely to fail because achieving adaptation goals requires the adoption of multiple strategies (George et al., 2019; Randall et al., 2012). Comprehensive planning for climate change at the farm level is required (George et al., 2007a,b,c).

### **What Is the Place for Risk Management and Best Management Practices?**

Risk management is the systematic application of management policies, procedures and practices to identify, analyse, assess, treat and monitor risks (ISO 14091, 2021). It incorporates choosing appropriate options to manage risks that are concomitantly encountered around climate, production and farm finances. Enhanced risks that are associated with climate change in the rangelands are associated with increased temperature and the extremes encountered with changes in the quantity, distribution and variability of rainfall. These create ecosystem hazards including heatwaves, droughts, reduced water security, bushfires and floods (McKeon et al., 2004), as have been described previously.

There are well-established protocols for prioritising risk management impacts in adapting to

climate change. Commonly applied risk management practices have been inadequate in managing drought generally because of the apparent combination of:

- (i) the drought's severity, extent and duration; and
- (ii) the inability of previously successful actions and adaptations that failed when experiencing extremes – impacts that are now being associated with climate change (Hacker & McDonald, 2021; Sattler, 2020).

Both the application of the precautionary principle and education underpin and enhance risk management practice (George et al., 2019; George, 2020; Lloyd et al., 2020).

### **Why Should the Precautionary Principle Be Considered and Used?**

The precautionary principle is a process for moving forward in the face of uncertainty and reducing the risk of rationally determined, adverse effects (Intergovernmental Panel on Climate Change (IPCC), 2021; World Commission on Environment and Development (WCED), 1987). While the science of climate change is clear, climate change projections remain uncertain because GHG emissions drive the change and are still increasing. This is because the amounts and types of GHG being emitted and mitigated globally are a result of policy decisions that are evolving (Intergovernmental Panel on Climate Change (IPCC), 2021). Future projections are thereby imprecise. Therefore, it is necessary to extrapolate the 'range' of 'optimistic' and 'pessimistic' future scenarios using scientific knowledge, due diligence and the (as yet) uncertain global responses. When an activity genuinely threatens harm to humans and ecosystems, precautionary measures should be taken, regardless of the effects not being fully understood. For this reason, *inter alia*, scientists are conducting research to limit increases in GHGs and to capture carbon (Dunstan, 2020; Meat and Livestock Australia (MLA), 2020).

Precautionary actions, when applied in the rangelands, should minimise and delay the impacts

of climate change. Rangeland managers would then have a greater role in ensuring future food security, both locally and globally, by adopting practices that enable better adaptation to climate change, and by capturing carbon. Assistance in the form of financial incentives, support and coordination as a new Carbon Economy – an economy driven by the imperative to limit carbon emissions – evolves (Lloyd & George, 2008) would help build capacity and accelerate best management practices.

### **How Can Applied Climate Education Address Such Complex Issues?**

The science of climate change is well established and has been well explained during the past three to four decades (Intergovernmental Panel on Climate Change (IPCC), 2021; McKeon et al., 1988; Paxton, 2021). There is a strong basis, then, for assisting rangeland producers in implementing both established and new options across all components of their businesses and their business management (Bode et al., 2020). Since each property is unique, plans for individual properties and circumstances need to be tailored to those specific characteristics (Monroe et al., 2017). Applied education has been used to achieve this (Clewett et al., 2011; Clewett, 2012; George et al., 2005, 2007a,b,c, 2009, 2016, 2019; Knowles, 1975). Accelerated processes to upscale management change are essential, not optional (Megalos et al., 2016) as the impacts of climate change are happening already.

### **What Is the Anti-science Message Around Climate Change, and What Are the Main Arguments of the Sceptics and Deniers?**

However, alternative views do exist. Despite science identifying and describing the effects of climate change and developing policies to mitigate against or adapt to them, an opposite view has been taken by many direct stakeholders and powerful voices in the Australian community (Burke, 2019; Gurney, 2021; Kennedy, 2019; Maiden, 2019; Mooney, 2005; SBS News, 2021).

For example, since 2007<sup>a</sup> the science surrounding anthropogenic-induced climate change has become highly politicised, central to which has

<sup>a</sup> The year 2007 is chosen only to highlight these issues – the level of politicisation that has occurred concerning climate change prior and post this time is subjective, with our reference list indicating key timelines of thought.



been a concerted, noisy media campaign from sceptics<sup>b</sup> and deniers. They have not only opposed the scientific basis of climate change but have been strongly driven by perceived negative economic implications. In addition, prominent politicians have labelled the climate change debate as a “distraction” (SBS News, 2021) and stated that “the idea Australia can stop climate change is ‘barking mad,’ and global warming is a better problem than the next ice age” (Maiden, 2019), and that “God is the solution to climate change” (Burke, 2019). The sociological impact of these views is to reinforce such values and opinions in the minds of the sceptics (Monroe et al., 2015).

Arguments used by climate change deniers and sceptics may be generally aggregated into:

1. The use of ‘short-term’ data in a ‘longer-term’ world in which climate has always been changing is questionable (thus promoting the view that current global warming is simply part of a ‘natural cycle’).
2. Overstated impacts are projected and promoted by scientists to meet their own ends.
3. Economic issues that question the relative significance of a particular sector (Maslin, 2019).

Even when considering these singularly or collectively, those in positions of influence, including government and industry, were (at the time of the Rangelands Dialogue) doing nothing differently than supporting standard extension and allied processes, and deeming them sufficient (George, 2020; Hacker & McDonald, 2021).

### Questionable Data

Data that are deemed ‘questionable’, based on the relatively ‘short’ duration of their collection, lead to a conclusion that the records on which climate projections are based are inadequate, and that climate change cannot be conclusively accepted and therefore should be rejected (Boycott, 2013; Crowley, 2021; Maslin, 2019). This accepts that whatever climate extremes prevail, they are part of the ‘normal

cycle’ and that scientists use ‘alarmism’ to gain investment for climate change projects (Crowley, 2021). This is accompanied by a belief that new and yet-to-be introduced ‘on-farm’ technologies *per se* (and not including climate risk management practices) will overcome the variabilities in a perceived ‘normal cycle’ of climate. Associated with this is a failure to recognise the lag time between the onset of the change itself, the observation of the effects of change, and the time needed to develop new technologies. For example, to genetically improve plants and animals, cycles are measured in years. This is likely to impact on and increase the effects of reduced capital returns to producers at times when stock numbers are rebuilt after drought. Ecosystem function data on which production from rangelands rely, e.g. grass growth, grass recruitment episodes and the occurrence of pests, weeds and diseases, seem also to be ignored. Those economists who proclaim the unreliability of climate data while taking an anti-climate change view seem at ease in relying on their own economic data to support their claims that technology will overcome such problems (Maslin, 2019; McCright & Dunlap, 2011; Oreskes & Stern, 2019).

### Overstated Impacts

As a result, the scientific impacts of the supposedly ‘questionable’ climate data are considered to be overstated – a compounding effect. Thus, the deniers and sceptics see no need to adjust long-standing management responses and no need to change risk-management priorities. The climatic extremes are simply a part of the ‘normal cycle’, which perpetuates the implementation of current ‘reactive’ responses. Therefore, potential ‘proactive’ approaches in which incremental and transformational adaptive or mitigation measures should be applied are deemed ‘politically’ unnecessary (Burke, 2019; Hare, 2021; Martin, 2021).

### Relative Insignificance

The agricultural/rangeland sector within the wide range of primary production industries is regarded

<sup>b</sup> Note, however, that an analysis of such arguments presented regularly by one journalist has shown them to be inconsistent with genuine scientific scepticism and to be largely ideologically driven (Gurney, 2017). Another high-profile journalist has consistently denied the link between the severity of drought, heatwaves, bushfires and water shortages to climate change, claiming that climate change is “a hoax”, and “there’s no evidence whatsoever to support [it]” (Kennedy, 2019).

as relatively insignificant by some economists, including Myron Ebell, Pat Michaels, Fred Singer and Sallie Baliunas (Boycoff, 2013; Crowley, 2021). Others take an opposite view (Garnaut, 2008, 2011; Stern, 2007). The former group tends to dismiss the allocation of funding to combat climate change as being of limited economic significance, which implicitly fails to accept the existence and impacts of climate change – thereby supporting a ‘denialist’ notion (Gurney, 2021; Kennedy, 2019; Maslin, 2019). The latter groups regard climate change action as imperative.

Despite this, the deemed insignificance of the economic value of the Queensland rangelands is arguably based on an incorrect premise. The Queensland rangelands carry about 63% of the state’s cattle herd of approximately 10.6 million head, a best estimate based on livestock numbers from Meat and Livestock Australia data for 2017 (Beef Central, 2017), or about 29% of the national cattle herd, thereby contributing about AU\$3.8 billion to Queensland’s economy through cattle products alone (Lloyd, 2021). Sheep and goat products are produced almost exclusively in the rangelands, but their contribution is lower compared to that of beef.

### **How Is It Possible to Overcome Such a Dichotomy of Beliefs and What Would Be the Benefits of Doing So?**

Since the decline of government-funded Research, Development and Extension (RD&E), services, e.g. in Queensland from 5% of the value of the proportion of agricultural gross value of production in the late 1970s to just over 3% in 2007 (Queensland Government, 2013), a decreasing role of publicly funded strategic extension has limited the focus on best practice management for the emerging risks of climate change. Needs to address climate change were identified by Barlow et al. (2011, 2013) and, to some extent, the challenges were recognised by the Rural Industry Research and Development Corporations (RIRDCs), the Grains Research and Development Corporation (GRDC, 2009, 2015) and industry (National Farmers Federation (NFF), 2015; AgForce, 2017). However, while there was an increase in implied action such as the breeding of better-adapted crop plants, there was a relative absence of direct ‘on-ground’ management and

an unwillingness to begin a process of perception change – so creating the necessity to convene the Rangelands Dialogue (Sattler, 2020).

Nevertheless, in 2021 there were signs of change (Rolfe et al., 2021). Farmers for Climate Action is a group of more than 6000 independent, non-politically aligned Australian farmers. Using science-based information, they are beginning to empower farmers, collectively, to take a lead on climate change action, particularly by putting significant pressure on government.

At the same time, RIRDCs are now investing in direct action to mitigate and adapt to the effects of climate change. For example, Meat and Livestock Australia (MLA) (2020) has initiated an ambitious, direct investment program ‘Becoming Carbon Neutral by 2030’ (the ‘CN30’ program) which, in conjunction with industry partners, government and research providers, is aiming to mitigate the emission of greenhouse gases by the livestock industries and adapt to the effects of climate change. This is planned through nine major research, development and adoption activities. These include:

- improving animal genetics, husbandry and nutrition to meet changed circumstances;
- reducing methane emissions from livestock;
- enhancing soil carbon sequestration and sequestration measurement processes;
- identifying further the role of dung beetles;
- studying the effects of new pastures, legumes and shrubs on lowering methane emissions; and
- developing renewable energy technologies in various ways.

The collaborative association of all stakeholders, from the conceptualisation of projects to the adoption processes employed, will determine the success of the program’s vision.

Away from the rangelands, GRDC (Dunstan, 2020) is investing initially in a partnership with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to gather baseline information around the levels of emission from the grains industries, to prioritise and develop a plan for emissions reduction. This is designed to provide stakeholders, nationally and internationally, with an optimistic, data-based pathway to understanding the baseline for future investment around climate

change – a pathway that includes identifying best management practices. This is also proposed to result in the development of a Grains Industry Sustainability Framework which would be led by grain grower organisations.

These considerable initiatives, *per se*, are likely to act as catalysts to a better understanding by producers of the science of climate change and its impacts on farm management and the research projects that are setting out to minimise those impacts. The CN30 initiative by MLA focuses particularly on the adoption of research outcomes by doubling prior investment in adoption practices. All projects within the CN30 initiative are using collaborative processes throughout, by creating partnerships between producers and all stakeholders (MLA, industry bodies, consultants, scientists, service providers and other agencies), supported by appropriate education and extension services and practices.

Adult learning education and extension processes, as proposed in the CN30 initiative and by other agencies and operatives, should provide a strong foundation to enhance a social osmosis of the adoption of climate change mitigation and adaptation measures, as well as an understanding of the science of climate change and its effects (see companion papers George et al., 2005, 2007a,b,c, 2009, 2010, 2011, 2016, 2019). These processes provide a platform for needs-based adult learning, untarnished by individualistic philosophy. Historically, extension services have been focused on technology transfer to increase production, sustain the natural resource and train farmers – the ‘do it this way’ approach. The adult education extension process proposed is not new, but refinements to implement a ‘better’ process will be proposed. It differs from the traditional technology transfer methodologies through facilitating the formation of farmer groups to deal collectively with issues relevant to the participants. The extension process should include learning about off-farm issues through partnering in the process with key off-farm stakeholders (George et al., 2019). Modern extension is thus the collective provision of ‘applied’ knowledge and skills by all organisations and personnel supporting all engaged in agricultural and pastoral production along the value chain, particularly producers (Davis, 2009).

### **What Are Some Fundamental Successful Principles and Approaches to Climate Change Already Being Used in Australia and Other Parts of the World That Could Effectively Be Applied to the Rangelands Now?**

Will current strategic extension processes focused on climate change and based on adult learning, such as within the CN30 initiative, be enough to enable deniers and sceptics to learn that climate change is real, and that its effects are immediate? Will this be adequate to address the dichotomy of opinion and change perceptions? The impetus gained through collaborative direct action now being initiated, e.g. through the CN30 initiative, should help create a direct focus on solutions to the effects of climate change. However, to create a more substantial belief in the science of climate change among pastoralists and producers in all other agricultural sectors, subtle processes – more subtle than are currently applied – will need to be adopted. Climate change ‘evangelism’, the ‘believe me’ approach adopted historically, is ill-advised and insufficient, and the various views that exist currently demonstrate that this simply does not work. More sensitive principles – principles that have not been effectively applied – need to be embedded within the adult learning extension process (George et al., 2019) and are broadly outlined below.

People are selective in what they choose and want to believe. Attitudes are formed by personal experiences and from trusted sources and individuals (Monroe et al., 2017). The climate change deniers and sceptics set their attitudes by believing in sources that they trust and that reinforce their beliefs. To ameliorate that and to enable change, a new and different trust must therefore be gained via appropriately facilitated processes. That will not occur quickly; it will require patience and skill, together with a progressive, consistent presentation of those processes needed to gain trust and approval. Highlighting already successful leaders is a good start. Analysing their ‘how-to’ is an example that presents principles worthy of emulation. Thus, the challenges in delivering an effective, unifying extension program around climate change to an audience of producers and stakeholders who have an array of existing beliefs about the science itself can be defined through four lenses (Bode et al., 2020):



1. *Climate change is complex, uncertain, and variable.* When confirming the scientific belief that climate change is real, the use of global and local warming data, together with easily relatable analogies around the occurrence of extremes, is recommended.
2. *People learn and remember selectively.* Be patient, provide time to record the observations of participants regarding their experiences of climate-based extremes, gain trust by avoiding a 'for and against' debate, initiate small group debate (stories and scenarios) that link the known to the unknown, and use a timeline to list a changing frequency of climate-based extremes.
3. *People pay attention to those who are like them.* Cultural settings need to be allowed for when planning and executing effective personal communications (Bode et al., 2020). Two groups these researchers commonly found in extension audiences when dealing with climate change were those that could be clumped into 'individualistic' and 'egalitarian' cohorts. The former favoured business ('market-driven') solutions, while the latter leaned more towards government action. The reasoning behind these different approaches was that one group thought the competitive arena leads to fairer outcomes (Kahan, 2010), while the other believed a governmental approach is more equitable. The main takeaway message we consider from these findings is to know your audience and their needs and provide specific information to satisfy both groups (George et al., 2016). Furthermore, the role of the extension process is to convey reality to an audience comprised of progressives and those who are more conservative. The process is a delicate balance, framing issues in a way that speaks to the values of the broad spectrum of participants, avoiding framing climate change messages around fear, but providing examples of local solutions to gain trust and relevance.
4. *Audiences vary and issues need to be simplified.* To reiterate, rangeland manager audiences possess wide-ranging beliefs and values around climate change and climate change management. Better audience trust and attention are likely to be gained through specific

use of simple agricultural examples that endorse best management practices and climate change risk management.

Therefore, evaluation of standalone and synthesised programs and projects (and the integration of authentic feedback into programs) should be integral to and help create a successful pathway that progresses adaptation and mitigation of climate change into the future (George et al., 2019). Nevertheless, we emphasise again that the process of delivery is vital to gain better acceptance and adoption of measures to adapt to climate change. A certain way to provoke people to ignore the climate change issue is to frame it within fear-based messages; however, presenting clear solutions helps to overcome this challenge (Center for Research on Environmental Decisions, 2009). People across all spectrums feel hopeless and helpless when given, without effective solutions, sensationalist messages on how climate change will reshape society as we know it. Extension processes must steer away from highlighting the potential for disaster, providing instead examples of local solutions and the benefits of adapting to and mitigating the extreme effects of climate change.

## Conclusion

The difference in opinion between those graziers and stakeholders who comprehend the reality of climate change and its impacts and urgency, and those who continue to deny and be sceptical, has frustrated rational extension process and related dialogue, particularly during the 21st century when the urgency to mitigate against and adapt to climate change has become evident. Extension processes in the northern rangelands of Australia have not been adequately successful, over a period of decades, in delivering research outcomes that have enabled a sustainable improvement to the condition of the natural resource, a condition that has trended downwards during periods of severe drought. Thus, we propose that the implementation of truly collaborative direct action, e.g. that of the MLA, together with an understanding and application of subtle adult learning extension processes that set out to gain trust during that process, will lessen the gap between acceptance and denial of climate change and its impacts within the farming communities.

This provides an opportunity for a new approach,

an approach that combines collaboration between all stakeholders, but particularly the graziers, and a more subtly focused action learning process. It is a great challenge that will involve new and existing skills around all facets of property, livestock and natural resource management, including issues beyond the farm gate, and extension processes that are finely adjusted to maximise the gaining of trust. Especially tailored extension can be successful if delivered in an authentic, trustful, respectful and non-threatening manner.

Companion papers (as mentioned previously and listed in our references) elaborate on more detailed specifics of the 'how-to' of effective climate change risk management and education principles. Such action is both urgent and important if timely actions are to be applied on ground. Accelerating the roll-out of better-qualified facilitators and educational courseware designed to address the impacts/options (adaptation and mitigation) of climate change in rangeland management is essential, not optional, and if applied and accelerated in rollout, will translate into improved socio-economic and environmental

benefits. It is recommended that any educational courseware should encompass on-farm plans that build capacity by way of the broad competencies: (1) surveying climate and enterprise data; (2) analysing climate risk; and (3) developing climate risk management strategies that align with industry best practice.

These embed within them the principles espoused previously: of respectful dialogue, and peer discussion that builds, not divides. Utilising local 'how-to' case studies that show how successful businesses, governments, individuals and communities have reduced their energy consumption or greenhouse gas emissions, or how they are implementing climate adaptation plans, will better enable success. This alone, however, is not enough. To reiterate Kahan (2010), educationalists need to learn and apply how to best present information in forms that are agreeable to culturally diverse groups, and how to structure debate so that it avoids cultural polarisation. As such, policy making has to be backed by the best science and a theory of risk communication that integrates culture in decision making.

### Acknowledgements

The authors appreciate the insightful comments from our reviewers.

### Literature Cited

- AIA (Ag Institute Australia) Policy Statement. (2018). *Climate Change – Australia's Adaptation and Resilience to Climatic Change and Variability*. Ag Institute Australia, Sydney.
- AgForce. (2017). *Grazing BMP: Best Management Practices*. AgForce, Brisbane.
- Anon. (2011). *Barriers to Effective Climate Change Adaptation: A Submission to the Productivity Commission*. Department of Climate Change and Energy Efficiency, Canberra.
- Anderegg, W. R. L., Prall, J. W., Harold, J., & Schneider, S. H. (2010). Expert credibility in climate change. *Proceedings of the National Academy of Sciences of the United States of America*, 107(27), 12107–12109. <https://doi.org/10.1073/pnas.1003187107>
- Arrhenius, S. (1896). On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground. *London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 41, 237–275.
- Barlow, S., Eckard, R., Grace, P., Howden, M., Keenan, R., Kingwell, R., McKellar, R., Meinke, H., Miller, C., Nelson, L., Russell, J., & George, D. A. (2013). *National Climate Change Adaptation Research Plan Primary Industries: Update Report 2013* (p. 53). National Climate Change Adaptation Research Facility, Gold Coast.
- Barlow, S., Grace, P., Stone, R., Gibbs, M., Howden, M., Howieson, J., Ugalde, D., Miller, C., Eckard, R., & Rowland S. (2011). *National Climate Change Adaptation Research Plan for Primary Industries* (p. 64). National Climate Change Adaptation Research Facility, Gold Coast.
- Bode, C. N., Monroe, M. C., & Megalos, M. (2020). *Strategies for Communicating Climate Change to Extension Audiences* (FOR333). School of Forest Resources and Conservation Department, UF/IFAS Extension, University of Florida.

- Bawden, R. J., Macadam, R. D., Packham, R. J., & Valentine, I. (1984). Systems thinking and practices in the education of agriculturalists. *Agricultural Systems*, 13(4), 205–225.
- Bawden, R. J. (2010). Messy Issues, Worldviews and Systemic Competencies. In C. Blackmore (Ed.), *Social Learning Systems and Communities of Practice* (pp. 89–101). Springer.
- Beef Central. (2017). *Australia's 20 largest regions for cattle population*. Retrieved 2 June 2022, from <https://www.beefcentral.com/production/australias-20-largest-regions-for-cattle-population/>
- Boycott, M. T. (2013). Public Enemy No. 1?: Understanding media representations of outlier views on climate change. *American Behavioural Scientist*, 57(6), 796–817. <https://doi.org/10.1177/0002764213476846>
- Briggs, H. (2020). Reflections on the Future Use of Pastoral Lands in Australia. *Proceedings of The Royal Society of Queensland*, 127 (A Rangelands Dialogue), 119–120.
- Bureau of Meteorology (BoM). (2018). *Annual Climate Statement 2018*. Bureau of Meteorology, Melbourne.
- Bureau of Meteorology (BoM). (2019). *Annual Climate Statement 2019*. Bureau of Meteorology, Melbourne.
- Bureau of Meteorology (BoM). (2020). *Annual Climate Statement 2020*. Bureau of Meteorology, Melbourne.
- Burke, L. (2019, 25 December). Barnaby Joyce suggests God is the solution to climate change in Christmas video. *Sydney Morning Herald*. <https://www.smh.com.au/politics/federal/barnaby-joyce-suggests-god-is-the-solution-to-climate-change-in-bizarre-christmas-video-20191225-p53mt4.html>
- Center for Research on Environmental Decisions. (2009). D. Shome, & S. Marx (Eds.), *The Psychology of Climate Change Communication: A Guide for Scientists, Journalists, Educators, Political Aides, and the Interested Public* (p. 55).
- Clewett, J. F., Murray, N., Collins, R., & Hickey, D. (2011). Grains Best Management Practice for Managing Climate Opportunities and Threats. *Proceedings of the Climate Change Research Strategy for Primary Industries Conference, NCCARF, Melbourne, February 15–17*.
- Clewett, J. F. (2012). *Developing and Implementing Grains Best Management Practices for Managing Climate Change and Climate Variability* (p. 76). Final technical report to AgForce Queensland on Aust. Govt Dept Agric, Fisheries & Forestry, FarmReady Project GMS – 0506.
- Crowley, K. (2021). *Climate wars, carbon taxes and toppled leaders: the 30-year history of Australia's climate response, in brief*. The Conversation.
- Davis, K. E. (2009). The Important Role of Extension Systems. *Agriculture and Climate Change: An Agenda for Negotiation in Copenhagen for Food, Agriculture, and the Environment* (Focus 16, Brief 11, May 2009).
- Denning, S. (2021). *Extreme heat waves in a warming world don't just break records – they shatter them*. The Conversation.
- Dunstan, K. (2020, 24 February). *GRDC Intensifies Focus on Greenhouse Emissions* [GRDC Media Release]. <https://grdc.com.au/news-and-media/news-and-media-releases/national/2020/february/grdc-intensifies-focus-on-greenhouse-emissions>
- Ecker, U. K. H., Lewandowsky, S., Cook, J., Schmid, P., Fazio, L. K., Brashier, N. M., Kendeou, P., Vraga, E. K., & Amazeen, M. A. (2022). The psychological drivers of misinformation belief and its resistance to correction. *Nature Reviews Psychology*, 1, 13–29. <https://doi.org/10.1038/s44159-021-00006-y>
- Farmers for Climate Action. (2021). Retrieved 6 February 2022, from <https://farmersforclimateaction.org.au/>
- Food and Agriculture Organization of the United Nations (FAO). (2013). *Climate Smart Agriculture*. Food and Agriculture Organization of the United Nations.
- Garnaut, R. (2008). *The Garnaut Climate Change Review: Final Report*. Commonwealth of Australia, Cambridge University Press.
- Garnaut, R. (2011). *The Garnaut Review 2011: Australia in the Global Response to Climate Change*. Cambridge University Press.

- George, D. A., Birch, C., Clewett, J. F., Wright, A., & Allen, W. (2005). Major issues and solutions to applied climate education in Australia. *Journal of International Agricultural and Extension Education*, 12(3), 21–31. <https://doi.org/10.5191/jiaee.2007.14201>
- George, D. A., Birch, C., Clewett, J. F., Wright, A., Allen, W., & Keogh, D. U. (2007a). Needs for applied climate education in agriculture. *Australian Journal of Experimental Agriculture*, 47(1), 1–12. <https://doi.org/10.1071/EA05244>
- George, D. A., Clewett, J. F., Birch, C., Wright, A., & 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. [https://doi.org/10.1300/J064v29n04\\_08](https://doi.org/10.1300/J064v29n04_08)
- George, D. A., Clewett, J. F., Wright, A., Birch, C., & Allen, W. (2007c). Improving farmer knowledge and skills to better manage climate variability and climate change. *Journal of International Agricultural and Extension Education*, 14(2), 5–19.
- George, D. A., Clewett, J. F., Birch, C. J., Wright, A. H., & Allen, W. R. (2009). A professional development climate course for sustainable agriculture in Australia. *Journal of Environmental Education Research*, 15(4), 417–441. <https://doi.org/10.1080/13504620902946978>
- George, D. A., Xie, M., Huan, Y., Paccieri, I. G. L., & Jeong, S. (2010). *Climate Change: An Overview of Key Concepts for Agriculture and Water* [CD-ROM]. World Bank Institute Climate Change Practice.
- George, D. A., Xie, M., Huan, Y., & Kleine, A. (2011). *A Climate Change Risk Matrix: Applications in Agricultural Water Management* [CD-ROM]. World Bank Institute Climate Change Practice.
- George, D. A., Tan, P. L., & Clewett, J. F. (2016). Identifying needs and enhancing learning about climate change adaptation for water professionals at the post-graduate level. *Environmental Education Research*, 22(1), 62–88. <https://doi.org/10.1080/13504622.2014.979136>
- George, D. A., Clewett, J. F., Lloyd, D. L., McKellar, R., Tan, P. L., Howden, S. M., Ugalde, D., Rickards, L., & 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. (2020). Introduction. *Proceedings of The Royal Society of Queensland*, 127 (A Rangelands Dialogue), 1–4.
- GRDC. (2009). *Risk Management for greater success in uncertain times* [Fact sheet] (p. 4). Grains Research and Development Corporation, Canberra.
- GRDC. (2015). *Grains industry national research, development and extension (RD&E) framework*. Grains Research & Development Corporation, Canberra.
- Gurney, M. (2021). Andrew Bolt and the discourse of ‘scepticism’ in the Australian climate change debate: a ‘distant reading’ approach using Leximancer. *Global Media Journal: Australian Edition*, 15(1).
- Hacker, R. B., & McDonald, S. E. (2021). Prospects for sustainable use of the pastoral areas of Australia’s southern rangelands: a synthesis. *The Rangeland Journal*, 43(4), 185–209. <https://doi.org/10.1071/RJ21036>
- Hare, W. (2021). *Yes, Australia can beat its 2030 emissions target. But the Morrison government barely lifted a finger*. The Conversation.
- Hine, D. W., Phillips, W. J., Reser, J. P., Cooksey, R. W., Marks, A. D. G., Nunn, P. D., Watt, S. E., & Ellul, M. C. (2013). *Enhancing climate change communication: Strategies for profiling and targeting Australian interpretive communities* (p. 85). National Climate Change Adaptation Research Facility, Gold Coast.
- Hoban, D. (2020). Putting Things Right in the Rangelands. *Proceedings of The Royal Society of Queensland*, 127 (A Rangelands Dialogue), 5–8.
- Intergovernmental Panel on Climate Change (IPCC). (2001). R. T. Watson, & Core Writing Team (Eds.), *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change* (p. 398). Cambridge University Press.

- Intergovernmental Panel on Climate Change (IPCC). (2013). Summary for Policymakers. In T. F. Stocker, D. Qin, G. K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, & P. M. Midgley (Eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (p. 27). Cambridge University Press.
- Intergovernmental Panel on Climate Change (IPCC). (2014). Summary for Policymakers. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, & L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (p. 32). Cambridge University Press.
- Intergovernmental Panel on Climate Change (IPCC). (2021). V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou (Eds.), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.
- ISO 14091. (2021). *Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment*. International Organization for Standardization, Geneva, Switzerland.
- Kahan, D. M. (2010). Fixing the Communications Failure. *Nature*, 463, 296–297. <https://doi.org/10.1038/463296a>
- Kennedy, E. (2019, 1 December). Conspiracy, commerce and climate denial: inside the parallel universe of Alan Jones. *The Guardian*. <https://www.theguardian.com/media/2019/dec/01/conspiracy-commerce-and-climate-denial-inside-the-parallel-universe-of-alan-jones>
- Knowles, M. M. (1975). *Self-directed learning: a guide for learners and teachers*. Association Press.
- Lloyd, D. L. OAM, & George, D. A. (Eds.). (2008). *Challenges and opportunities for agriculture in a changing carbon economy* [Symposium Proceedings]. Australian Institute of Agricultural Science and Technology (Queensland Division).
- Lloyd, D. L. OAM., George, D. A., & Clewett, J. F. (2020). Climate change adaptation, risk management and education to meet needs in the Rangelands. *Proceedings of The Royal Society of Queensland*, 127 (A Rangelands Dialogue), 51–55.
- Lloyd, D. L. OAM. (2021). A productive journey – sown pastures for southern inland Queensland – Key Contributions. *Agricultural Science*, 32(2), 37–50.
- Luke, R. H., & McArthur, A. G. (1986). *Bushfires in Australia*. Australian Government Publishing Service, Canberra.
- Maiden, S. (2019, 10 July). ‘Barking mad’: Barnaby Joyce slams the idea we can fix climate change. *The New Daily*. <https://thenewdaily.com.au/news/2019/07/10/barnaby-joyce-climate-change/>
- Martin, P. (2021). *Australia’s top economists back carbon price, say benefits of net-zero outweigh cost*. The Conversation.
- Maslin, M. (2019). *The five corrupt pillars of climate change denial*. The Conversation.
- McCright, A. M., & Dunlap, R. E. (2011). Cool dudes: The denial of climate change among conservative white males in the United States. *Global Environment Change*, 21(4), 1163–1172. <https://doi.org/10.1016/j.gloenvcha.2011.06.003>
- McKeon, G. M., Howden, S. M., Silburn, D. M., Carter, J. O., Clewett, J. F., Hammer, G. L., Johnston, P. W., Lloyd, P. L., Mott, J. J., Walker, B., Weston, E. J., & Willcocks, J. R. (1988). The effect of climate change on crop and pastoral production in Queensland. In G. I. Pearman (Ed.), *Greenhouse, Planning for Climate Change* (pp. 546–563). CSIRO Division of Atmospheric Physics, Melbourne.
- McKeon, G., Hall, W., Henry, B., Stone, G., & Watson, I. (Eds.). (2004). *Pasture Degradation and Recovery in Australia’s Rangelands: Learning from History* (Vol. QNRME04130). Department of Natural Resources, Mines and Energy, Brisbane.



- Meat and Livestock Australia (MLA). (2020). *Becoming Carbon Neutral by 2030*. Retrieved 2 June 2020, from [www.mla.com.au/globalassets/mla-corporate/research-and-development/documents/cn30-information-sheet-final.pdf](http://www.mla.com.au/globalassets/mla-corporate/research-and-development/documents/cn30-information-sheet-final.pdf)
- Megalos, M., Monroe, M. C., & Bode, C. N. (2016). *Risk Perception and Needs: Defining Extension's Climate Change Adaptation Role* (FOR335). School of Forest Resources and Conservation Department, UF/IFAS Extension, University of Florida.
- Monroe, M. C., Bode, C. N., & Megalos, M. (2017). *Challenges in Communicating Climate Change to Extension Audiences* (FOR324). School of Forest Resources and Conservation Department, UF/IFAS Extension, University of Florida.
- Monroe, M. C. (2015). Harnessing homophily to improve climate change adaptation. *Environmental Education Research*, 21(2), 221–238. <https://doi.org/10.1080/13504622.2014.910497>
- Mooney, C. (2005). *The Republican war on science*. Basic Books.
- NASA. (2021). *Shifting Distribution of Northern Hemisphere Summer Temperature Anomalies, 1951–2011*. National Aeronautics and Space Administration, USA. <https://svs.gsfc.nasa.gov/3975>
- National Farmers' Federation (NFF). (2015). *National Farmers' Federation Annual Review 2014–15: AgForce Segment* (pp. 50–198). National Farmers' Federation, Barton, ACT.
- Naughten, K. (2012, 3 April). *Climate Change and Heat Waves*. ClimateSight: Climate science from the inside. <https://climatesight.org/2012/04/03/climate-change-and-heat-waves/>
- Oreskes, N., & Stern, N. (2019, 5 November). What's the price of ignoring climate change? *The New York Times*. <https://www.nytimes.com/2019/11/05/opinion/climate-change-economics.html>
- Paxton, G. (2021). Building cultural capital in drought adaptation: lessons from discourse analysis. *The Rangelands Journal*, 43(3), 101–108.
- Queensland Government. (2013). *Department of Agriculture, Fisheries and Forestry agricultural research, development and extension plan: Contributing to the 2040 vision to double Queensland's agricultural production*. Department of Agriculture, Fisheries and Forestry, Brisbane. [https://www.daf.qld.gov.au/\\_data/assets/pdf\\_file/0010/105112/RDE-plan-web.pdf](https://www.daf.qld.gov.au/_data/assets/pdf_file/0010/105112/RDE-plan-web.pdf)
- Randall, A., Capon, T., Sanderson, T., Merrett, D., & Hertzler, G. (2012). *Making decisions under the risks and uncertainties of future climates*. National Climate Change Adaptation Research Facility (NCCARF), Canberra. <https://nccarf.edu.au/making-decisions-under-risks-and-uncertainties-future-climates/>
- Recher, H. F., Lunney, D., & Dunn, I. (1990). *A Natural Legacy: Ecology in Australia* (2nd ed.). Pergamon.
- Reser, J. P., Bradley, G. L., Glendon, A. I., Ellul, M. C., & Callaghan, R. (2012). *Public risk perceptions, understandings, and responses to climate change and natural disasters in Australia and Great Britain*. National Climate Change Adaptation Research Facility, Gold Coast.
- Rolfe, J., Perry, L., Long, P., Frazer, C., Beutel, T., Tincknell, J., & Phelps, D. (2021). GrazingFutures: Learnings from a contemporary collaborative extension program in rangeland communities of western Queensland, Australia. *The Rangelands Journal*, 43(3), 173–183.
- Sattler, P. (Ed.). (2020). *A Rangelands Dialogue: Towards a sustainable future*. *Proceedings of The Royal Society of Queensland*, 127.
- SBS News. (2021, 9 February). *Matt Canavan says climate change debate is a 'distraction' as he threatens to cross the floor*. SBS News. <https://www.sbs.com.au/news/matt-canavan-says-climate-debate-a-distraction-as-he-threatens-to-cross-the-floor>
- Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. Cambridge University Press.
- Stokes, C., & Howden, S. M. (Eds.). (2010). *Adapting agriculture to climate change: preparing Australian agriculture, forestry and fisheries for the future*. CSIRO Publishing, Canberra.
- Thomas, R. J., de Pauw, E., Qadir, M., Amri, A., Pala, M., Yahyaoui, A., El-Bouhssini, M., Baum, M., Iñiguez, L., & Shideed, K. (2007). Increasing the Resilience of Dryland Agro-ecosystems to Climate Change. *SAT eJournal*, 4(1), 1–37.
- Vraga, E. K., & Bode, L. (2017). Leveraging institutions, educators, and networks to correct misinformation: A commentary on Lewandowsky, Ecker, and Cook. *Journal of Applied Research in Memory and Cognition*, 6(4), 382–388. <https://doi.org/10.1016/j.jarmac.2017.09.008>

- Vraga, E. K., Tully, M., & Bode, L. (2020). Empowering Users to Respond to Misinformation about Covid-19. *Media and Communication*, 8(2), 475–479. <https://doi.org/10.17645/mac.v8i2.3200>
- World Commission on Environment and Development (WCED). (1987). *Our Common Future, From One Earth to One World*. Oxford University Press.

### Author Profiles

David Llewellyn Lloyd, OAM, FAIA, FTGSA, MAIA, is Honorary Research Fellow at the School of Agriculture and Food Sciences, University of Queensland. Formerly, he was Principal Pasture Agronomist at the Queensland Department of Primary Industries (now Department of Agriculture and Fisheries). He was responsible for managing the Queensland Department of Primary Industries component of pasture plant improvement and development for pasture/crop systems in sub-tropical southern inland Queensland. He was involved in the release and development of 24 new legume and grass cultivars, and developed and delivered the ‘LeyGrain’ pasture education/extension program.

Dr David Alan George is Adjunct Associate Professor at the Australian Rivers Institute, Griffith University. Formerly, he was Senior Natural Resources Management Specialist with the Climate Change Practice [WBI] at The World Bank. Dr George has developed, delivered and evaluated applied climate courses in the primary industries sector. He established national accreditation of ‘Developing climate risk management strategies’ into the Australian Qualifications Framework.