CSIRO PUBLISHING
www.publish.csiro.au/journals/trj
Guest Editorial
The Rangeland Journal, 2011, **33**, i–iii

Rain on the Rangelands – Adaptive management is alive and functioning

A. J. Pressland

Kenmore, Qld 4069, Australia. Email: apressla@bigpond.net.au

This issue of *The Rangeland Journal* includes papers presented at the Australian Rangeland Society 16th Biennial Conference held at Bourke, western New South Wales, in 2010. The organisers of the Conference determined its theme to be *Rain on the Rangelands*, 'coined in the midst of a prolonged drought and declining flows in inland rivers (in Australia)' (Anon. 2010) – conditions which had existed in many rangeland areas of Australia for over ten years (BOM 2006). The drought was largely broken during 2010 and the 2011 summer (BOM 2011*a*). Indeed, some falls were exceptional, and exceeded previous records (BOM 2011*b*).

This extreme of climatic variables is characteristic of rangelands across the world. The authors of an Intergovernmental Panel on Climate Change report comment 'Because extremes drive rangeland systems . . . small changes in the frequency of extreme events may have a disproportionate effect on what management must cope with in these systems' (Allen-Diaz 1995). As an example of how flooding rains in rangeland Australia are critical to the survival of natural systems, Libby Robin (Robin 2007), in her book 'How a continent created a nation', argued that flood water was the major driver for the breeding cycle of the banded stilt (*Cladorhynchus leucocephalus*) – a bird which depends on flooding to initiate its breeding cycle and provide the food source for its hatchlings. The birds could vanish completely from an extensive area only to return when the inland flooded. It was not until 1930 that this was recognised. Thus, Libby Robin emphasised the 'overwhelming importance of rainfall as a driver of its ecosystems' (quoted from Whalley 2007).

This then leads to the hypothesis that unless there is a system of rangeland management which is cognizant of extremes and changing values of variables, we are not going to be able to continue managing rangeland resources – whether they be people, animals, natural resources of soil, water and vegetation – for the breadth of purposes and uses required in the 21st Century. Foran (2007) in his reflections on trends impacting Australian rangelands, refers to the book by Walker and Salt (2006) on resilience theory, and points out that resilience in rangelands will depend on our overcoming failures in present systems of management – particularly those which focus too narrowly on improving efficiency and optimization – and learning to understand the whole system – and importantly, the role that humans play in it.

In recent years there has been an upsurge in interest in adopting adaptive management approaches to management of natural resources and agricultural systems (e.g. Roling and Wagemakers 2000; Williams 2011). Adaptive management concerns a process of learning by doing (Walters and Holling 1990) – reviewing the situation; implementing a change; recording effects of the change; interpreting the change; modifying the system in the light of the change; and continuing the cycle by regular monitoring of outcomes.

Adaptive management is seen as a way of dealing with the complexity and extremes of ecosystems such as rangelands (Gunderson 2008) which are also dynamic and unpredictable. These ecological systems not only include the sub-systems of function and biophysical relationships in rangelands; they also include the cultural, economic and social systems which will prove to be of great importance for the future well being of society.

People may be considered the central part of rangeland ecology. Rangelands now have very diverse uses and users; for example, mining and tourism are major uses, while rangelands continue to offer indigenous peoples real opportunities for connecting spiritually with the landscape. Whereas, fifty years ago the main users of rangelands were those involved in livestock production (e.g. landholder, shearer, ringer – livestock musterer – stock and station agent) and indigenous peoples, now there are large numbers of itinerant workers in the mining industry, and even larger numbers of travelers enjoying the aesthetic, scenic and spiritual values that rangelands offer. The social system has changed accordingly.

Part of the social system includes how we communicate with others. Indeed, the feedback from scientists to policy makers and those managing rangelands is critical (Seely *et al*. 2008); dissemination of results and their interpretation in a manner acceptable to the end user is a core component of this criticality.

Janssen *et al*. (2000) also point out that spatial scale can influence perceptions and behaviour of visitor and land occupier. For example, the pastoralist or range manager is most interested in what happens on his or her own enterprise base; a regulator is more interested in influencing the behaviour of many pastoralists across a region. Similarly, temporal scales influence the outcomes of so many natural systems. For example, State and Transition models, introduced by Westoby *et al*. (1989), demonstrate conclusively that vegetation changes occur in response to stimuli

10.1071/RJv33n2_ED 1036-9872/11/02000i

such as rain, drought, fire and grazing, yet are dramatically influenced by the timing of such factors. For Australia, a workshop held in 1993 under the Meat Research Corporation (now Meat and Livestock Australia) resulted in the publication of a range of models for different rangelands systems (see *Tropical Grasslands* (1994) Volume 28, number 4). Further, oral presentations by rangeland managers at the 16th Australian rangeland Conference highlighted the point that the impacts of management changes in rangelands could only be measured in periods of years if not decades (e.g. the presentations of David Lillicrap, David Pollock, Ben Forsyth and Deb Kaluder – (ARS 2010)).

The papers contained in this issue of the Rangeland Journal may be seen as expressions of adaptive management. They focus on changes to either the rangeland system to improve services (Brown and MacLeod 2011) or to highlight functional and structural change in the system (Whalley *et al*. 2011); identify the influence of trees on the spatial distribution of pasture (Barnes *et al*. 2011); examine the effect of livestock management on landscape condition (Walsh and Cowley 2011); manipulate access to water to reduce the impact of feral goats (Russell *et al*. 2011); monitor and comment on the mechanical treatment of degraded rangelands (Wakelin-King 2011).

As rangelands are large and heterogeneous systems (Brown and MacLeod 2011), these authors promote the use of an ecological site based system for assigning ecological services to specific units of rangelands and linking them closely to the ecosystem outputs. They point out that the success of such an arrangement will be dependent on comprehensive soil and vegetation data, a strong research and development network to provide information, and a network of science and management organisations to interpret changes, which may be seen as operating within a state and transition model.

Whalley *et al*. (2011) describe the changes in the wetland ecosystems of the Gwydir Wetlands and Macquarie Marshes in the Murray–Darling River catchments of New South Wales which have occurred over the last 200 years. Most of the changes were a result of actions which were taken in the absence of useful information on their possible impacts – contrary to the recommendations of Brown and MacLeod (2011). They describe five adaptive phases in a system which has also been subjected to sequences of flooding and drying. The learnings through understanding of these phases will be instrumental in determining how to move the system from its present degraded state to one which is sustainable for future conservation and production purposes. Social, environmental and economic factors will need to be considered if such an outcome is to be achieved.

Continuing the theme of rangelands being complex adaptive systems (Gross *et al*. 2006), rangeland landscapes can be a combination of trees, shrubs and ground flora. Woodlands and shrublands dominate the rangelands of Australia – for example, ~100 M Ha of Queensland are dominated by forests, woodlands or shrublands compared with 40 M Ha of natural grasslands (Burrows *et al*. 1988). Thus it is important to understand the impact of woody species on the ground flora. Barnes *et al*. (2011) used optical sensors with integrated GPS as well as more conventional techniques to examine the distribution of ground flora biomass and its nutrient status in relationship to soil type and trees. Such information allows a better interpretation of impacts of changes in rangeland structure on vegetation dynamics and thus contributes to improved outcomes through adaptive management.

Modelling has been used widely in rangelands, particularly in addressing the impacts of climate change and variability (e.g. McKeon *et al*. 2009) and livestock grazing (e.g. Johnston *et al*. 1996). In their paper, Walsh and Cowley (2011) investigate the effectiveness of using the safe utilisation concept within a modelling framework to determine the number of livestock that can be profitably carried long-term yet still maintain land condition. They show that careful collection of historical information on commercial operations, together with comprehensive modelling of pasture production, can successfully lead to safe stocking rates in rangelands of the Northern Territory.

Water, the theme of the 2010 Australian Rangeland Conference, is a major key to sustainable rangelands – or at least understanding the importance of its presence – and absence – is. Water is required for all aspects of rangeland production and the maintenance of its biodiversity. Ecological services need water; vegetation needs water; animals need water. The latter point is the focus of the paper by Russell *et al*. (2011). They in effect use adaptive management to understand the impact of withdrawal of water on an animal species – the feral goat – which has potential to cause damage and reduce condition of rangeland landscapes. These authors describe how they constructed fences to restrict access to water by goats. They did this by understanding that goats could only graze a maximum of four kilometers from water. They measured the presence of goats with and without fencing at a paddock scale, and were able to reduce the impact of goats significantly.

Rehabilitation of rangelands to a functional landscape involves ensuring that basic processes such as capturing energy, retention of water and nutrient cycling are restored, habitats for living populations are provided, and the material, cultural and spiritual needs of people are sustained (Tongway and Ludwig 2011). This type of rejuvenation process is slow and can take decades. Gresley Wakelin-King (Wakelin-King 2011) understands this and examines the impact of treatments imposed up to four decades previously to rehabilitate hard setting soils, stoney gilgaied country and stoney runoff areas. She found that the geomorphological features affected treatment success, and provides some guidance for achieving successful renovation of different rangeland landscapes through appropriate mechanical means and managing total grazing pressure.

In its own way, each of these papers gives substance to adaptive management. Each has elements of defining and analysing problems (Whalley *et al*. 2011); designing solutions (Russell *et al*. 2011; Wakelin-King 2011); selecting and implementing changes (Walsh and Cowley 2011); monitoring, interpreting and evaluating indicators (Barnes *et al*. 2011; Brown and MacLeod 2011); and going through the learning process repeatedly. Adaptive management, whether purposefully or intuitively, has been an approach taken by many rangeland managers and reported often. This issue of the Rangeland Journal is no exception. The key ingredient is learning from doing, recording the outcomes and communicating them to those who need to know. It is no more, no less than that!

References

Allen-Diaz, B. (1995). Rangelands in a Changing Climate: Impacts, Adaptations, and Mitigation. Chapter 2. *In*: 'Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses'. IPPC Working Group II Report. (Eds R. T. Watson, M. C. Zinyowera and R. H. Moss.) pp. 132–158. (IPCC Working Group II: Stanford.) Available at: www.ipcc-wg2.gov/publications/SAR/ (accessed 25 May 2011)

Anon. (2010). Foreword. Rain on the rangelands. *In*: 'Australian Rangeland Society 16th Biennial Conference'. Bourke, New South Wales, 26–30 September 2010. (Australian Rangeland Society 16th Biennial Conference Organising Committee)

ARS (2010). Rain on the rangelands. *In*: 'Australian Rangeland Society 16th Biennial Conference'. Bourke, New South Wales, 26–30 September 2010. (Australian Rangeland Society 16th Biennial Conference Organising Committee)

Barnes, P., Wilson, B. R., Trotter, M. G., Lamb, D. W., Reid, N., and Koen, T. (2011). The patterns of grazed pasture associated with scattered trees across an Australian temperate landscape: an investigation of pasture quantity and quality. *The Rangeland Journal* **33**, 121–130.

BOM (2006). Bureau of Meteorology. An exceptionally dry decade in parts of southern and eastern Australia: October 1996–September 2006. Special Climate Statement 9. P. 9. Available at: www.bom.gov.au/climate/current/special-statements.shtml (accessed 26 May 2011).

BOM (2011*a*). Bureau of Meteorology. Special climate statements. Available at: www.bom.gov.au/climate/current/special-statements.shtml (accessed 26 May 2011).

BOM (2011*b*). Bureau of Meteorology, National Climate Centre, 2011. Wettest March on record in Australia. Special Climate Statement 31, p. 11. www.bom.gov.au/climate/current/statements/scs31.pdf (accessed 26 May 2011).

Brown, J., and MacLeod, N. (2011). A site-based approach to delivering rangeland ecosystem services. *The Rangeland Journal* **33**, 99–108.

Burrows, W. H., Scanlan, J. C., and Anderson, E. R. (1988). Plant ecological relations in open forests, woodlands and shrublands. *In*: 'Native Pastures in Queensland – The Resources and their Management'. Chapter 6. Information Series QI87023. (Eds W. H. Burrows, J. C. Scanlan and M. T. Rutherford.) pp. 72–90. (Department of Primary Industries, Queensland Government: Brisbane.)

Foran, B. D. (2007). Sifting the future from the past: a personal assessment of trends impacting the Australian rangelands. *The Rangeland Journal* **29**, 3–11. doi:10.1071/RJ07019

Gross, J. E., McAllister, R. R. J., Abel, N., Stafford-Smith, D. M., and Maru, Y. (2006). Australian rangelands as complex adaptive systems: A conceptual model and preliminary results. *Environmental Modelling & Software* **21**, 1264–1272. doi:10.1016/j.envsoft.2005.04.024

Gunderson, L. (2008). Adaptive management and integrative assessments. *In*: 'Encyclopedia of Ecology'. (Eds J. Sven Erik and F. Brian.) pp. 55–59. (Academic Press: Oxford.)

Janssen, M. A., Walker, B. H., Langridge, J., and Abel, N. (2000). An adaptive agent model for analysing co-evolution of management and policies in a complex rangeland system. *Ecological Modelling* **131**, 249–268. doi:10.1016/S0304-3800(00)00256-8

Johnston, P. W., Tannock, P. R., and Beale, I. F. (1996). Objective 'safe' grazing capacities for south-west Queensland Australia: model application and evaluation. *The Rangeland Journal* **18**, 259–269. doi:10.1071/RJ9960259

McKeon, G. M., Stone, G. S., Syktus, J. I., Carter, J. O., Flood, N., Fraser, G. W., Ahrens, D. G., Bruget, D. N., Crimp, S. J., Cowley, R., Johnston, P. W., Stokes, C. J., Cobon, D. H., Ryan, J. G., Day, K. A., and Howden, S. M. (2009). Climate change impacts on rangeland livestock carrying capacity: a review of issues. *The Rangeland Journal* **31**, 1–30.

Robin, L. (2007). 'How a Continent Created a Nation.' (UNSW Press: Sydney.)

Roling, N. G., and Wagemakers, M. A. E. (2000). 'Facilitating Sustainable Agriculture: Participatory Learning and Adaptive Management in Times of Environmental Uncertainty.' (Cambridge University Press: Cambridge.)

Russell, B. G., Letnic, M., and Fleming, P. J. S. (2011). Managing feral goat impacts by manipulating their access to water in the rangelands. *The Rangeland Journal* **33**, 143–152.

Seely, M., Dirkx, E., Hager, C., Klintenberg, P., Roberts, C., and von Oertzen, D. (2008). Advances in desertification and climate change research: are they accessible for application to enhance adaptive capacity? *Global and Planetary Change* **64**, 236–243. doi:10.1016/j.gloplacha.2008.07.006

Tongway, D., and Ludwig, J. A. (2011). 'Restoring Disturbed Landscapes: Putting Principles into Practice.' Society for Ecological Restoration International. (Island Press: Washington, DC.)

Wakelin-King, G. (2011). Using geomorphology to assess contour furrowing in western New South Wales. *The Rangeland Journal* **33**, 153–171.

Walker, B. H., and Salt, D. (2006). 'Resilience Thinking: Sustaining Ecosystems and People in a Changing World.' (Island Press: Washington, DC.)

Walsh, D., and Cowley, R. A. (2011). Looking back in time: can safe pasture utilisation rates be determined using commercial paddock data in the Northern Territory? *The Rangeland Journal* **33**, 131–142.

Walters, C. J., and Holling, C. S. (1990). Large-scale management experiments and learning by doing. *Ecology* **71**, 2060–2068. doi:10.2307/1938620

Westoby, M., Walker, B. H., and Noy-Meir, I. (1989). Opportunistic management for rangelands not at equilibrium. *Journal of Range Management* **42**, 266–274. doi:10.2307/3899492

Whalley, R. D. B. (2007). Book review. The Australian Rangeland Society. *Range Management Newsletter* 07/2, 13–15.

Whalley, R. D. B., Price, J. N., Macdonald, M. J., and Berney, P. J. (2011). Drivers of change in the Social-Ecological Systems of the Gwydir Wetlands and Macquarie Marshes in northern New South Wales, Australia. *The Rangeland Journal* **33**, 109–119.

Williams, B. K. (2011). Adaptive management of natural resources—framework and issues. *Journal of Environmental Management* **92**, 1346–1353. doi:10.1016/j.jenvman.2010.10.041