Towards Sustainability for
AUSTRALIA’S RANGELANDS
Analysing the options

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The Australian rangelands occupy three-quarters of the Australian continent and are environmentally diverse. The rangelands’ economy and its communities are highly dependent on the use of natural resources. The rangelands provide substantial benefits to Australia in terms of vegetation, carbon, water and biodiversity.

Pronounced regional differences in rangelands’ climate, soils, vegetation and management issues make delivery of ecologically and economically sustainable development highly dependent upon spatial information.

Pastoralism is critical to the ecological sustainability of the Australian rangelands because of the large area it occupies, its dependence on natural resources and its central role in land management.

Pastoralism in the rangelands is sustainable where economic resilience and stability can be achieved along with regional persistence of native species and the maintenance of other ecosystem services.

Open and flexible spatial multi-criteria analysis tools are required to analyse trends in the condition of natural resources in the rangelands and to evaluate competing demands and trade-offs. This capacity is essential for informed decision-making by government, regional groups and industry.
Introduction

The Australian rangelands occupy approximately three-quarters of the continent. They support diverse communities and businesses and make an important contribution to Australian society.

The rangelands are landscapes where land use is dominated by pastoralism — extensive sheep and cattle grazing on native pastures (Figure 1). Rainfall is generally too low or too variable for dryland cropping or grazing on improved pastures. The rangelands include areas of comparatively undisturbed ecosystems — typically tropical savannas, woodlands, shrublands and grasslands — extending across arid, semiarid and some seasonally high rainfall areas (NLWRA 2001).

Understanding the implications of alternative land-management options for the rangelands is important because of the large area of Australia they occupy and the reliance of rangeland communities and industries on sustainable management of natural resources. The rangelands offer the opportunity to realise substantial natural-resource benefits for Australia in terms of vegetation, carbon, water and biodiversity outcomes.

Significant economic and social changes are currently taking place in the rangelands, and rangeland ecosystems are under pressure. The task is to ensure that development opportunities are taken up, ecological processes are maintained and options for the future are not lost.

Charting the course to a sustainable future for the rangelands presents a challenge because of the extent of the rangelands, the diversity of environmental, economic and social factors affecting outcomes, limited availability of information, and the wide range of community views and aspirations. This means that analysis must be able to accommodate spatial variation in relationships between social and environmental factors. This brief presents a way forward for examining these complex relationships in ways that promote the engagement of stakeholders, account for alternative views and enable the analysis of policy options.
Some important questions

Questions raised in the context of sustainable production and natural-resource management in the rangelands include:

- Where are the most economically productive parts of the rangelands?
- Where are the ecologically significant parts of the rangelands?
- Where do grazing and agriculture face structural adjustment pressure?
- What are the constraints and opportunities for further development of grazing and agricultural industries in Australia?
- Where is there a strong or emerging tension between pastoral production and the desire to conserve native flora and fauna?
- How do grazing systems impact on the ecological health of rangeland environments and native biodiversity?
- How do feral animals, weeds, pests and fire impact on pastoral production and native flora and fauna?
- What are the demographic and socioeconomic trends in the rangelands and what impact do these have on the capacity of rural communities to achieve sustainability and manage structural adjustment?

Patterns of use

Almost 60% of the rangelands are managed for livestock production (Table 1) by pastoral enterprises that operate under state and territory leasehold land administration. Pastoralism has contributed significantly to the economy of the rangelands but is under increasing market, environmental and economic pressures as product quality, production and ecological sustainability, and water-resource issues challenge aspects of livestock production.

Mining, tourism, defence, intensive irrigated agriculture, communications and the activities of Indigenous communities are also increasingly important aspects of the rangelands’ economy. Mining and tourism in the rangelands collectively contribute about 2.8% to Australia’s gross domestic product (GDP). This contrasts with pastoralism, which in 2000–01 contributed gross revenue of $1.8 billion, or about 0.2%, to GDP (NLWRA 2001).

A generalised representation of land use and agricultural-commodity production in the rangelands is shown in Figures 1 and 2, respectively. Variation in the intensity of stocking by domestic grazing animals, primarily cattle and sheep, is shown in Figure 3.

**FIGURE 1 The rangelands of Australia**
### TABLE 1 Australian rangeland land use

<table>
<thead>
<tr>
<th>Land use</th>
<th>Proportion of rangelands (%)</th>
<th>Proportion of Australia (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation</td>
<td>5.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Native vegetation — grazed</td>
<td>60.0</td>
<td>55.9</td>
</tr>
<tr>
<td>Native vegetation — ungrazed</td>
<td>32.0</td>
<td>28.4</td>
</tr>
<tr>
<td>Production forestry</td>
<td>0.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Dryland agriculture</td>
<td>0.7</td>
<td>5.5</td>
</tr>
<tr>
<td>Irrigated agriculture</td>
<td>0.1</td>
<td>0.3</td>
</tr>
<tr>
<td>Intensive use</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Water</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>No data</td>
<td>0.0</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**FIGURE 2** Agricultural activity in Australia's rangelands — commodities  
Source: Hajkowicz and Young (2002)

**FIGURE 3** Stocking rates in Australia's rangelands  
Source: estimates developed from the Australian Bureau of Statistics Agricultural Commodity Census 2001; watered areas from the National Wilderness Inventory Biophysical Naturalness data and land-tenure data
**Rangeland environments**

Climatic variability is a characteristic of the Australian rangelands and an important control on biophysical processes and landscape function. The effectiveness of rainfall can vary considerably between years, seasonally and across the landscape. Several major droughts and wet periods have been experienced in the century or more of pastoralism in the rangelands; with cycles ranging from annual to decadal. In eastern Australia, extreme droughts and floods have been associated with interaction of the El Niño Southern Oscillation and the Inter-decadal Pacific Oscillation (NLWRA 2001).

Landscape and vegetation patterns in the Australian rangelands are spatially variable and functionally complex, making responses to disturbance, including management actions, difficult to predict. Permanent changes in system function are also slow to emerge and hard to detect. Major disturbance factors in Australian rangelands include grazing by domestic stock, grey and red kangaroos, and a wide variety of feral animals including rabbits, goats, camels, horses and donkeys. Dingoes, foxes and cats are major predators on native animals.

The Australian rangeland environments can be characterised by:

- **vegetation communities**, which help define ecosystems and habitats (Figure 4)
- **net primary productivity**, which integrates climate and vegetation to show productive potential for natural biota and human use (Figure 5)
- **reliability of annual rainfall**, which controls the consistency of water-resource inputs and habitat resources (Figure 6)
- **reliability of winter–spring rainfall**, which indicates the potential for safely carrying livestock through the dry season in the northern half of Australia (Figure 7).

**FIGURE 4 Vegetation communities in Australia’s rangelands**

Source: National Vegetation Information Systems 2000
FIGURE 5 Net primary productivity of Australia's rangelands

Source: modelled data produced by Commonwealth Scientific and Industrial Research Organisation (CSIRO) Land and Water using a variety of inputs including meteorological services, the Atlas of Australian Soils and satellite imagery

FIGURE 6 Reliability of annual rainfall in Australia's rangelands

The policy challenge

The Australian Government is presently promoting sustainability objectives through regionally based natural-resource investment programs such as the National Landcare Program and the Natural Heritage Trust. State governments are working to secure appropriate agreements through their pastoral leasehold systems. Specific initiatives such as bore capping, adoption of improved management practices, market-based instruments, stewardship and management agreements are also being promoted.

The future role of extensive livestock grazing is critical to the long-term sustainability of the rangelands due to the size of the area it occupies, its dependence on native vegetation and water resources and its central role in land management. In particular, the influence of livestock grazing varies spatially, since landscape access is controlled by distance from water and land tenure. Although sustainability issues affecting this industry are complex and vary regionally, some general observations can be made (Stafford Smith et al. 2000):

- Rangeland ecosystems vary in management risk and susceptibility to damage resulting from inappropriate land management.
- Economically optimum production may not always support the long-term regional sustainability of ecosystems and processes.
- Low-productivity environments will only support a modest investment in restoration.

More broadly, issues relevant to rangelands sustainability can be expressed in a number of ways. One approach is to characterise issues in terms of ‘tensions’ between competing assets and processes. Hill et al. (2006) have characterised this in terms of the competing demands of the natural-resource base (the biophysical assets and natural processes of a fully functional environment), the production base (assets utilised by humans for economic purposes), and threatening processes (natural and human-induced processes that may interact to reduce both ecological function and economic productivity) (Figure 8).
There is a key role for science in developing understanding of dynamics in rangeland systems and linking this understanding to policy development. Over the last 10 years, considerable attention has been paid to landscape-scale biophysical interactions that control processes involved in maintenance of landscape functional integrity (e.g., Ludwig et al. 2004). However, increased scientific understanding has not necessarily translated to better rangeland management. The relationship between scientific and land-user interpretations of land degradation and change are often distinct and even opposed.

As a result, policy makers are paying increased attention to links between biophysical understanding of change processes in rangelands and the mechanisms for dealing with the implementation of regulatory and voluntary changes by land managers. Recently established initiatives, such as the Australian Collaborative Rangelands Information System, are providing the information base to track changes in rangeland condition (Box 1). However, this new perspective also points to the need for tools and techniques to support the integrated spatial analysis of economic, environmental and social factors that drive rangeland systems — and the evaluation of alternative land-use and management options. Multi-criteria analysis (MCA) is one method of achieving this (Box 2).

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**Tracking changes in rangeland condition**

The Australian Collaborative Rangeland Information System (ACRIS) is a system established by the Australian, state and Northern Territory governments for the collection and analysis of information for monitoring and reporting on the Australian rangelands. It:

- coordinates the collation of rangeland information
- undertakes monitoring and reporting of change
- disseminates information amongst rangeland managers, advisors, administrators and policy makers.

Key interests for ACRIS include landscape function and ecosystem change, biodiversity change, sustainable water-resource management, social and economic change, and climate variability. ACRIS has tested national reporting capacity for the rangelands, providing an initial glimpse of change across five pilot regions. The adequacy of the information base for national rangeland change monitoring is an issue for ACRIS.

ACRIS partners have adopted an agreed rangeland boundary based on the Interim Biogeographic Regionalisation for Australia (IBRA) (Thackway and Cresswell 1995).

ACRIS activities are coordinated by a management unit located within the Desert Knowledge Cooperative Research Centre. ACRIS forms part of the National Land and Water Resources Audit’s national natural-resource information-coordination arrangements.

Multi-criteria analysis

Government policy makers, local authorities and land managers with responsibility for resource-management decision-making often need to access and analyse large amounts of environmental, social and economic information. The transparent and logical treatment of this information and the use of value judgments incorporating public opinion and policy and management goals can be achieved using multi-criteria analysis (MCA). Well-developed MCA approaches generally share a number of characteristics including:

- flexibility in combining data layers
- an ability to capture quantitative and qualitative data and issues
- simplicity for client and stakeholder use
- facilities for developing alternative scenarios
- a capacity to explore relationships (including trade-offs between biophysical, economic and social phenomena)
- methods enabling stakeholders to factor results into decision-making

The interactive process of analysis can be described in six steps:

- define the problem and decision criteria
- identify variables that influence decision criteria
- assemble data inputs and establish relative rating
- design operations and functions for synthesis
- develop viewpoint profiles with interest groups
- discuss the results, develop a consensus view or redefine the problem.

The Bureau of Rural Sciences (BRS) has developed a flexible, easy-to-use software tool that helps implement the MCA process by promoting insightful desktop manipulation of different types of mapped information and interactive ‘live update’ and mapping of alternative scenarios (Hill et al. 2005).

A spatial multi-criteria analysis requires the transformation of information describing complex processes, interactions, trends and constraints governing natural and human systems into map layers that make understandable descriptive connections to objectives. Composite indexes describing target themes are created using rigorous methods and participatory workshopping.
Exploring policy questions — a case study

A spatial multi-criteria approach can be helpful in examining specific aspects of sustainability in the rangelands. Extensive livestock grazing, for example, has been addressed at a broad scale using multi-criteria approaches (Stafford Smith et al 2000, Hill et al 2006).

Livestock grazing in the rangelands can be characterised as sustainable where economic resilience and stability can be achieved in conjunction with regional maintenance of native species and other ecosystem services. Sustainability may be under threat where there is potential for pastoral production but ecosystems have limited resilience. Informed public policy requires an understanding of where in the landscape these ecological and economic controls are operating. Policy implications arising from the interplay between the potential productivity of the natural-resource base and its sensitivity to livestock grazing is shown in Figure 9.

BRS is investigating the productivity and resilience of rangeland landscapes under livestock grazing. Analysing patterns in a range of biophysical and socioeconomic factors provides an insight as to their collective contribution to long-term sustainability. An example of how relevant factors may be combined as a series of indexes to represent potential productivity is shown in Figure 10. Potential productivity will generally be greater where:

- landscapes have higher productive potential (forage potential)
- rainfall is relatively consistent within and between seasons
- there is better access to markets, supplies and labour.

Views of other relevant target themes, such as sensitivity of the resource base and total grazing pressure, may be similarly derived (Figure 11). Analysing the relationship between these factors will assist in the assessment of sustainability and the identification of appropriate forms of policy response. The public interest may be threatened in regions where the resource base is sensitive to livestock grazing and pastoral land use is viable in terms of potential or actual grazing productivity (Stafford Smith et al 2000).
FIGURE 10 Creating a view of potential productivity for livestock grazing in Australia’s rangelands

Note: A representation of potential productivity for livestock grazing on conforming tenures in the rangelands. This view was created by the weighted combination of indexes of forage potential (comprising measures of plant growth, foliage projected cover and soil nutrient potential), rainfall reliability (based on measures of rainfall reliability) and accessibility to services (based on the Accessibility/Remoteness Index for Australia). Analysis was completed using the Bureau of Rural Sciences’ MCAS-S spatial multi-criteria analysis software tool (Hill et al. 2005).
The way forward

Mapping pathways to sustainability and prosperity for the Australian rangelands requires decision-making in a context of risk and uncertainty. Communities, rural industries and governments need information about the changes that are taking place, an appreciation of the forces that are bringing about these changes, and a capacity to identify and compare outcomes.

Biophysical, social and economic information is becoming increasingly available. The Australian Collaborative Rangeland Information System (ACRIS), for instance, is building national capacity to collate rangeland information and monitor and report changes in conditions ‘on the ground’.

However, informed debate about competing demands on natural resources and the desirability of alternative futures requires the use of spatially explicit decision-support tools, such as the spatial multi-criteria analysis tool being developed by BRS (MCAS-S; Hill et al., 2005). These tools can facilitate stakeholder and participatory processes that forecast likely landscape scenarios and the natural-resource issues shaping them. They can also explicitly account for the regional differences in the Australian rangelands, including deep-seated environmental and economic constraints.

The use of evaluation procedures suggested here can help target policies more effectively, to promote appropriate development and develop incentives to get management right. This could include measures such as specific public investment in regional restructuring and negotiated trade-offs or, at the property scale, the application of negotiated agreements to achieve off-reserve conservation goals. These elements are vital to the achievement of a sustainable and prosperous future for this significant part of Australia.

FIGURE 11 Linkage of target themes to explore sustainability in the Australian rangelands

Note: A series of theme views may be developed and then combined to explore sustainability questions. Creation of a view of potential productivity for grazing is described in Figure 9. Sensitivity of resource base to livestock grazing may be developed on the basis of the susceptibility of soils and vegetation to degradation, landscape heterogeneity (patchy landscapes are more difficult to manage), water abstraction rates (where water resources for livestock are independent of rainfall) and rainfall variability (management is more difficult where rainfall is non-seasonal or more variable). Total grazing pressure may be rated on the basis of the combined stocking rates of cattle, sheep, native (kangaroos) and feral herbivores (e.g. rabbits, horses, goats, camels, etc). The relationship between these theme views can be explored using spatial and statistical techniques.
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