

FOREWORD

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Australia is the world's driest inhabited continent, and the management of water, in all its forms, continues to be a dominant force shaping where Australians live and what they do. Providing access to water, and its storage, transport and treatment, are major national enterprises involving many billions of dollars of capital assets and employing thousands of people. During the first 150 years following European settlement, a sizeable proportion of the nation's wealth was sunk into water management, particularly in the development of irrigation schemes to enable intensive production in what are basically semi-arid regions. More recently, the past development of water resources in the south of the country has been matched by continued developments in the north. The infrastructure for water management is an important component of Australia's capital stock, and it provides the basis for income-producing industries that are vital in many parts of regional Australia.

After the Second World War, Australians' interest in water resources began to change to consider issues of water quality as well as quantity. In part, this was due to unmistakable signs of deteriorating water quality in some parts of the country, particularly increasing salinity, sedimentation, and nutrient inflows from both point and diffuse sources. Recent surveys show that in many river systems, and in some groundwater systems, water quality continues to deteriorate through poor or careless management.

More recently still, our interest in water resources has moved on further to consider the health of aquatic ecosystems and the terrestrial systems that they interact with. There is genuine and increasing concern about the continued deterioration in the health of many of our river systems, reflected in an upsurge of interest in stream restoration and sustainable management. This has been matched by an increasing emphasis on river, wetland and floodplain health in research and development programs.

It is against this background of changing understanding and attitudes to our water resources, that this issue of *The Rangeland Journal* looks at the use and management of water in the rangelands. The aim of the group of papers that follows is not to deal in detail with all issues of water management. This would be impossible even in a large volume, given the diversity of issues and their changing significance across different rangeland regions. Rather, the approach taken is to provide examples of how water influences rangeland ecosystems, and to draw out some of the crucial issues that must be considered if we are to use and develop these water resources in an ecologically sustainable manner. Hence, for the purposes of this issue, "water resources" has been defined broadly to include rainfall (and climate variability), surface waters, groundwater, and the effects of manmade watering points. Together, these papers provide a broad overview of the range of water management issues that must be considered by those who live in the rangelands and manage their resources.

Water, in the form of rainfall, is the dominant driving force for many rangeland ecosystems. It is a crucial variable for the extensive grazing industries, which still represent by far the major land use (by area) in the rangelands. The variability of rainfall pattern in season and amount is well-known. Managing a sustainable grazing enterprise subject to long-term patterns in rainfall that may extend for much of, or even between, a human generation time, and in an ecosystem shaped by major events with return times of several human generations, is a substantial challenge. In recent years, improved understanding of the forces driving global climatic patterns, including the El Niño phenomenon, have raised the possibility of much-improved

longer-term rainfall forecasts. Improved ability to forecast the probability of particular rainfall patterns over a 6-12 month period would be a major step forward in assisting the grazing industries to manage their enterprise in a highly-variable climate to much better effect.

The first paper on climate change by McKeon and colleagues discusses the relationship between annual rainfall and temperatures and the El Niño/Southern Oscillation (ENSO) phenomenon, and the long-term changes in these relationships. The important issue raised here is that if we can understand the driving forces behind the changes in this relationship, we will be in a much better position to use the ENSO phenomenon as a good predictor of future rainfall patterns. Although a great deal of progress had been made in this topic over the last 5 to 10 years, there is scope for substantial further development aimed at providing rangeland managers with both longer-term and more-certain weather forecasts.

The second paper on climate change, by Hall and colleagues, looks at the broad-scale effects of long-term climate change on the grazing industries in Queensland. It discusses possible long-term changes in rainfall, temperature, and carbon dioxide levels, and uses models of native pasture and animal production to examine the potential effects of these changes on the carrying capacity of native pastures.

Once rainfall arrives at the ground surface, is it distributed evenly or is it concentrated in certain areas, how effective is it at producing plant biomass in different parts of the landscape, and what is the influence of grazing management on rainfall distribution and effectiveness? These questions are addressed in the paper on herbage production by Noble, Greene and Muller. Their results show that in a mulga woodland in western New South Wales, the size of the rainfall event was an important determinant of rainfall distribution and effects. Rainfall redistribution can have important effects on herbage production, both in particular zones and across the landscape as a whole. The implications for management are that light to moderate grazing is required to maintain landscape heterogeneity and overall production, and that monitoring procedures must take account of different land system zones if they are to be effective.

The next two papers deal with different aspects of surface water management. Many of Australia's inland rivers flow only intermittently, but they periodically carry massive flows as a result of high-rainfall events over large catchments. We are gradually coming to appreciate that these periodic flow events are the primary drivers for important rangeland ecosystems, particularly the floodplain lakes and billabongs that underpin the large migratory populations of water birds. At the same time, those streams and wetlands are coming under intense pressure for irrigation development. The paper by Thoms and Cullen argues that it is not sensible to make long-term decisions about the abstraction of water for large-scale irrigation development without a sound understanding of the physical and biological character of inland river systems. These systems have received relatively little attention in the past, but because of their intrinsic variability it is likely that plans to remove even a small proportion of flood flow would have serious ecological consequences. Recent work on the Coongi lakes system shows that removal of a proportion of the peak flood flow has large effects on the eventual distribution of floodwaters into the terminal lakes system. Concepts of flow management derived from more-certain temperate rivers cannot be applied to rangeland systems, as has been shown by data for the Barwon-Darling and the Cooper.

This theme is taken further in the paper by Seddon and Briggs on the lakes in the western division of New South Wales. In the semi-arid climate of this region, the great majority of lakes are naturally ephemeral. Some of these lakes have now been made permanent through construction of flood control structures, and others are subject to increasing salt and nutrient levels as a result of land clearing and management practice in the surrounding area. Some of the fresh lakes that fill intermittently from a river system have lakebed cultivation permits, although such development tends to be concentrated in particular locations. These lakes are

also likely to have high conservation values, as they are able to support different ecosystems. The paper argues that large, freshwater lakes on leasehold land that remain uncropped should be a focus for voluntary conservation agreements with landholders.

The paper by Pauline English extends the theme of rainfall distribution to a much larger temporal and spatial scale. The paper outlines the nature of the palaeovalley between Uluru and Kata Tjuta. During rainfall, a distinctive sheet flow phenomenon is a highly-effective recharge mechanism that maximises infiltration and water conservation. It assists the survival of the mulga groves in the surrounding landscape, and of the underground aquifer that is a major source of water for natural biota, traditional owners and the increasing number of tourists. Sub-surface supplies are the major source of water for 60 per cent of Australia, and sustainable groundwater management is a crucial issue in much of the rangelands. Understanding the nature of the aquifer system, and particularly careful management of recharge zones, is a high priority for sound rangeland management.

The final paper in this series, by Noble *et al.*, looks at the impacts of human-induced changes in water management within the Great Artesian Basin. Two particular issues are addressed. The first is that development of the rangelands for extensive grazing by domestic stock has led to a huge increase in the availability of water, through the construction of bore drains and provision of tanks or windmills with open water supplies. Estimates made by Ross Blick for the Cunnamulla region suggests that there are now several hundred kilometers of water available in bore drains, and that the number of watering points has increased at least one-hundredfold. The effects of this now ready-availability of what was formerly a very scarce resource has allowed more widespread grazing by livestock and by larger native and feral herbivores. There is now data available that shows this poses considerable threats to native plants and animals that do not use the artificial water supplies and that may be sensitive to the grazing that it allows. Evidence suggests that grazing-sensitive species are now confined to a few, tiny patches in the landscape that cannot be reached by grazing animals.

The second issue raised in this paper is that the over-development of water resources in the GAB has led to wide-scale falls in water levels and reductions in pressure. This has serious implications for the continued viability of the mound springs, which represent natural outlets of artesian groundwater within the Basin. The springs themselves provide unique habitats for rare and endangered biota, and they are also important components for the surrounding ecosystem. The Great Artesian Bore Rehabilitation Program is being funded by governments to support the rehabilitation and closure of uncontrolled water bores, and already there are signs of reversal in some areas of past falls in groundwater levels and pressures. However, the program is progressing slowly, and there is also a need to develop more-effective management of mound springs and the surrounding areas.

As you will see, the papers in this issue aim to provide a glimpse across a wide range of important water management issues in Australia's rangelands. There is still much to be learnt about the functioning of surface and groundwater resources, in order to expand our capacity to manage them sustainably, and to deal both directly (through water management) and indirectly (through grazing management) with the primary driving force in the rangelands of a highly-variable climate. In temperate, southern Australia, water is more and more being recognised as a highly-valuable but scarce resource, and there is increasing conflict over its allocation to competing uses. With the expansion of tourism and other industries within the rangelands, and the growing awareness of our need to conserve unique Australian ecosystems, it seems likely that such pressures will also increase in the rangelands. The key to making sound decisions, whether at national or property level, is understanding the nature of our water resources and what we need to do to protect and conserve them in a healthy state for use by future generations.