Soil, plant and livestock interactions in Australian tropical savannas

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Australian savannas and grazing impacts This paper considers the various soil, plant and livestock interactions occurring in Australia's wet-dry savanna rangelands. These regions are relatively intact compared to most of the world's rangelands. However there is increasing pressure for more intensive use of the landscape, especially from pastoralism. This potentially threatens landscape health, function and productivity through reduced soil health and a loss of digestible perennial plants, especially given the low soil fertility and highly variable rainfall characteristic of these regions. There is an obvious need for understanding these impacts to devise sustainable management practices that promote soil health and viable perennial plant communities, and the restoration of soil health where required.

Retaining and optimising the utilisation of nutrients and water in the landscape is critical to maintaining landscape function and productivity. Patches of perennial vegetation play an important functional role in retaining and cycling nutrients and water. Soil macro-faunal assemblages are vital to the maintenance of fertile vegetation patches. For example, through their feeding and nesting activities they create soil macropores that facilitate water infiltration and retention. Grazing has the potential to reduce the capacity of the landscape to capture and retain water and nutrients through changes in patch and vegetation structure and dynamics.

Grazing effects can be manifested at scales ranging from small patches to whole landscapes. At larger scales, grazing can affect the structure, size, function, spatial arrangement and demography of vegetation patches. The tendency for livestock to repeatedly graze preferred locations also results in the development of degraded vegetation patches. At smaller scales, grazing can influence soil and plant processes in a number of ways; for example, the beneficial effects of macrofauna on soil processes can be adversely affected by grazing (T. Z. Dawes-Gromadzki, unpublished data). Demographic processes in perennial plant populations can also be disrupted by grazing and lead to local extinction of desirable species (Hunt, 2001). All these impacts affect the capture, retention and distribution of nutrients and water, with potential negative consequences for landscape function and productivity in the long term. Understanding how these processes interact and knowing which are the key drivers of system health are fundamental requirements for successful management but our current level of knowledge is poor.

Potential pathways of grazing impact It is unlikely that the various soil and plant processes are equally affected by grazing, so there may be different pathways through which grazing effects can lead to declines in range condition, landscape health and productivity. Hypothetical pathways for grazing effects include:

1. Direct changes in soil processes occur more rapidly than plant changes and subsequently limit plant growth and reproduction. For example, are the effects of trampling on soil compaction, surface-sealing and macro-fauna activity in restricting nutrient and water availability to plants the overriding limitation on the persistence of desirable species?
2. Plant changes occur more rapidly than soil changes. For example, are changes in plant population and community processes (e.g. reproduction, growth and species composition) the overriding limitation on the persistence of desirable species, with soil changes being of less importance?
3. Soil and plant changes occur simultaneously and at similar rates. If so, what are the critical processes?
4. Grazing only affects plant processes directly, with consequences that then flow on to soils (e.g. a reduction in transpiration that alters soil moisture status in cracking soils).
5. Grazing only affects soil processes directly with consequences that then flow on to plants.

Possible implications for research and management The potential importance of these interactions demonstrates the need for a systems approach with integrated studies. Such a framework should indicate what the critical issues are for management to focus on. For example, to avoid degradation should management focus on plant processes, whereas for restoration, should soil processes be the focus?

References

Hunt, L.P. (2001). Heterogeneous grazing causes local extinction of edible perennial shrubs: a matrix analysis. *Journal of Applied Ecology,* 38, 238-252.