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Evaluation of vegetation indices for assessing vegetation cover in southern arid lands in South Australia

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Abstract. Vegetation indices are widely used for assessing and monitoring ecological variables such as vegetation cover, above-ground biomass and leaf area index. This study reviewed and evaluated different groups of vegetation indices for estimating vegetation cover in southern rangelands in South Australia. Slope-based, distance-based, orthogonal transformation and plant-water sensitive vegetation indices were calculated from Landsat thematic mapper (TM) image data and compared with vegetation cover estimates at monitoring points made during Pastoral Lease assessments. Relationships between various vegetation indices and vegetation cover were compared using simple linear regression at two different scales: within two contrasting land systems and across broader regional landscapes. Of the vegetation indices evaluated, stress related vegetation indices using red, near-infrared and mid-infrared TM bands consistently showed significant relationships with vegetation cover at both land system and landscape scales. Estimation of vegetation cover was more accurate within land systems than across broader regions. Total perennial and ephemeral plant cover was best predicted within land systems, while combined vegetation, plant litter and soil cryptogam crust cover was best predicted at landscape scale. These results provide a strong foundation for use of vegetation indices as an adjunct to field methods for assessing vegetation cover in southern Australia.

Additional keywords: arid environment, Landsat TM, rangelands.

Introduction

Vegetation cover has been widely recognised as one of the best indicators for determining land condition (Booth and Tueller 2003; Bastin and Ludwig 2006; Wallace *et al.* 2006). Consequently, land condition is often assessed and monitored according to vegetation cover and its variations in time and space. This cover is, therefore, often used as an indicator in the remote sensing of land condition. Remote sensing has developed as a powerful tool in environmental studies (Oštir *et al.* 2003) because it can provide calibrated, objective, repeatable and cost effective information for large areas and it can be empirically related to field data collected by traditional means (Graetz 1987; Tueller 1987; Pickup 1989). One of the most common applications of remote sensing is vegetation monitoring and assessment via vegetation indices which combine reflectance measurements from the bands of sensing instruments (Pickup *et al.* 1993; Bannari *et al.* 1995; Purevdorj *et al.* 1998; Thiam and Eastman 2001). However, most of the widely used vegetation indices are inappropriate in arid and semi-arid environments of Australia where perennial vegetation dominates. These plants often lack the contrast between red and infrared reflectance upon which the common vegetation spectral indices are based, making them difficult to distinguish from red-coloured soils. Several alternative multispectral indices that place less emphasis on vegetation infrared response are more appropriate and have been widely used in Australian arid and semi-arid rangelands (Foran and Pickup 1984; Pickup and Nelson 1984; Pickup and Foran 1987; Pickup *et al.* 1993; McGregor and Lewis 1996; O'Neill 1996).

Grazing lands held under pastoral leases cover 85% of the state of South Australia. The administration of these lands is governed by the South Australian Pastoral Land Management and Conservation Act, 1989, which aims to ensure sustainable utilisation and resource maintenance and which also provides for effective monitoring of the condition of the lands. Assessment and monitoring the condition of the pastoral lands has been undertaken by the Pastoral Management Branch of the Department of Water, Land Biodiversity and Conservation, under the direction of the Pastoral Board. In the southern sheep-grazing lands two methods are used for monitoring and assessing land condition; a land condition index and permanent monitoring sites, both field-based methods (Department of Water, Land Biodiversity and Conservation 2002). For the land condition index, land condition is determined through comparison with descriptions and photo standards at numerous randomly located sites on each lease. In addition, permanent monitoring sites have been established in most paddocks to determine temporal trends in land condition. Sampling at some of these sites is repeated at infrequent intervals and comprises assessment of plant density and cover, together with repeated photography from a photopoint (Department of Water, Land Biodiversity and Conservation 2002).

Although these ground-based methods provide detailed data about specific sites at infrequent monitoring intervals, they

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