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VEGETATION COVER MONITORING USING LANDSAT MSS IN WESTERN NSW

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ABSTRACT

Temporal Landsat MSS data for a single image area is being used to develop a satellite-image-based rangeland vegetation cover monitoring system. This system will expand the current ground-based Rangeland Assessment Program (RAP) to provide a spatially complete picture of vegetation cover. The data from the RAP sites are being used to statistically verify the developed vegetation indices. Subjective assessment of albedo-derived cover maps revealed some promising results.

INTRODUCTION

The rangelands of western NSW are held under perpetual lease upon which certain management limitations are imposed. At present, a spatially complete picture of rangeland condition is not available. There is a need for an objective means of assessing the effects of different management regimes on rangeland condition. Such a system would indicate the areas requiring more careful scrutiny to ensure sustainable meat and fibre production and the conservation of the natural resources in western NSW.

Vegetative cover is the primary regulator of soil degradation through its ability to minimise the detrimental effects of wind and water, particularly in the arid and semi-arid zones of Australia. Landsat MSS data have the potential to supply land managers with a cost-effective method of monitoring vegetative cover over large areas of the arid and semi-arid zones of Australia. A temporal sequence of Landsat MSS data for a single scene, centred around the Ivanhoe district in western NSW, is being used to develop vegetation indices to monitor vegetative cover. Vegetation and soil data collected annually by the Department of Land and Water Conservation at Range Assessment Program (RAP) sites across the scene are being used to validate vegetation indices derived from MSS data. The aim is to develop a practical and cost-effective satellite-image-based rangeland monitoring system, complementary to the ground-based program, using relatively simple processing methods on standard image processing/GIS software. This paper contains preliminary results of this research study.

METHODS

The Ivanhoe standard scene area (94/83) was chosen for the pilot study due to a good spread of RAP sites over a wide variety of different rangeland types. Landsat MSS data were considered the most suitable satellite data due to their adequate spectral coverage, good temporal frequency, low cost (per unit area) and the availability of long-term archival data. The RAP site size (300 × 300 m) suits MSS data. As rangeland vegetation temporal dynamics are important (Pickup *et al.* 1993), a sequence of MSS images was acquired to represent major changes in vegetation related to rainfall patterns. Monthly NOAA AVHRR NDVI satellite data were used to visually assess the seasonal vegetation changes. As the operational system requires a minimum of pre-processing, no atmospheric correction or other image normalisation was applied (apart from that built into the albedo technique). Suitable temporal comparisons can be made without complex normalisation provided the changes to be monitored are greater than the temporal 'noise' and a partially normalising vegetation index is used.

Numerous vegetation indices have been developed and trialled in semi-arid environments in other States of Australia. Indices used in higher rainfall zones (i.e. NDVI) are not suited to monitoring rangelands where vegetation is generally dry. Indices trialled in this investigation included NDVI (for comparison only), Band 5/7 ratio (Foran 1987), total image albedo (Robinove 1981), Band 5, PD54 (Pickup *et al.* 1993), and 'soil cover' according to LIBRIS methods (Graetz *et al.* 1986).

RESULTS

Initial correlation results are shown in Table 1. Although a number of correlations are significant, they are not strong enough to use in a predictive capacity. The LIBRIS vegetation cover index was found to have the greatest correlation with ground data. Total canopy cover had the highest level of correlation whereas shrub density had the greatest number of significant correlations with vegetation indices.

Table 1. Initial correlations (r) of vegetation indices with RAP site data. * $P < 0.05$, ** $P < 0.01$.

Vegetation index	Total biomass	Total canopy biomass	Shrub density	% Bare soil	% Pasture cover
Total Albedo	0.09	0.52**	0.25**	0.20*	0.03
Band 5/7 ratio	0.25**	0.00	0.28**	0.07	0.22*
NDVI	0.02	0.03	0.31**	0.07	0.02
Band 5	0.07	0.15	0.24*	0.05	0.11
LIBRIS Cover	0.24*	0.60**	0.54**	0.01	0.30**

Visual field assessment of an albedo mean/standard deviation false colour composite image during a dry season has shown good subjective agreement between the image product and ground cover. This image highlights areas with high long-term mean albedo, high variability in albedo or a combination of the two. Areas with a high mean albedo showed chronically low vegetation cover. Areas with high albedo variability were dominated by annual species which show a 'boom and bust' cycle of vegetation cover, whilst areas with low mean albedo and a low albedo variability were dominated by perennial species.

DISCUSSION

This project has highlighted the apparent incompatibility of the RAP data with satellite-derived data. Many sites are covered by chenopods which are only measured by the number per unit area in the ground-based assessment and not by percentage cover. Variability in the canopy size of individual shrubs varies the total canopy, which may not be proportional to the number of shrubs measured. Cryptogams (biotic soil crusts) appear very similar to plants in satellite images at certain times of the year due to photosynthetic activity, yet at other times appear more like bare soil. Some sites have a significant cover of trees which partially masks the changes in pasture plants underneath, with no practical way to separate the effects of trees from the pasture reflectance. The integration of ground cover features by the satellite probably accounts for the poor correlations. Further analysis of the RAP data will be required to separate the effects of different cover components.

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