RANGELAND MONITORING WITH MODIS 250M DATA

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ABSTRACT

Satellite based monitoring techniques have been developed and utilised extensively throughout the rangelands of Australia. This study evaluates the capability of 250m MODIS visible red band data for monitoring changes in vegetation cover upon north Australian rangelands.

Initial results indicate that MODIS data are able to track changes in rangeland vegetation upon red and black soil landscapes. The visible red band proved to be effective in monitoring changes of vegetation cover levels over a 12-month temporal sequence.

INTRODUCTION

The management of rangelands is very diverse and complex. Vastness, sparse populations and harsh conditions are major factors that contribute to the lack of data and information, which consequently affects the monitoring of rangeland condition. Rangeland monitoring based on satellite imagery has been identified as an important tool to assess conditions and landscape processes of rangelands (Pickup *et al.* 1993, Bastin *et al.* 1998).

Within the Northern Territory, satellite based monitoring techniques are being used to assess the conditions of rangeland utilised by the pastoral industry in the Victoria River District (VRD) and Sturt Plateau regions. Landsat Multi Spectral Scanner (MSS) and Thematic Mapper (TM) data are combined with ground based data to provide information on landscape cover change and processes. Current techniques provide monitoring information between years, at the end of the growing season. For improved commercial and sustainable management decisions, information is required throughout the year, when management decisions can be altered to suit current conditions.

A new generation satellite, Moderate-resolution Imaging Spectro-radiometer (MODIS) offers a possible solution, with increased spectral and temporal capabilities, to provide real time monitoring within a season. A Tropical Savanna CRC funded project aims to evaluate the capabilities of 250m MODIS visible red and near-infra-red (NIR) band data for mapping changes to rangeland condition in the VRD, NT for 2003 to 2004.

This paper evaluates the capabilities of 250m MODIS visible red band data for monitoring changes in vegetation cover throughout north Australian rangelands.

METHODS

The methods used for the project involve the integration of ground data with MODIS satellite imagery. It is a progressive application of techniques and methods developed and used for the satellite-based rangeland-monitoring program implemented within the Northern Territory (Wallace *et al.* 1994, Tongway and Hindley 1995, Karfs *et al.* 2000, Furby and Campbell 2001).

Study Area

Victoria River Downs is one of the oldest properties in the Victoria River District. The VRD region and Victoria River Downs have been the centre of many rangeland studies resulting in 'data rich' areas with extensive vegetation, soil, land resource and cattle production data available.

Data

Fortnightly acquisitions of cloud free 250m MODIS data from January 2003 to January 2004 were used. This included the visible-red band (B1) and the near-infra-red band (B2). Imagery was sourced from the TERRA satellite to provide consistency with departmental Landsat datasets. For the months of the wet season only a monthly image was selected due to the weather conditions and high levels of cloud cover experienced during this time. During December 2003 the TERRA satellite was not operational thus no data were acquired in this month. Imagery was supplied by the Western Australian Department of Land Information (DLI) following geometric, radiometric and atmospheric correction.

Site data utilised consisted of field observations, permanent monitoring sites and local knowledge from pastoralists. To provide consistency between the different types of site data, classification of the sites was necessary. The presence/absence of perennial grass species was used to separate sites into good and poor condition classes. This is consistent with the Landscape Function Analysis (LFA) approach of Tongway and Hindley (1995). Thus, poor sites will have very few to no perennial grass species, while a good site will be dominated by perennial grass species.

Due to the resolution of satellite imagery, 250m pixels, it was necessary to select homogeneous sites with a minimum size of 250m. As a consequence, the majority of poor sites were located at or near bores, while good sites were located at some distance from watering points. For the analysis of red soils, a total of 16 sites was selected across the property – eight representing areas of good condition and eight representing poor condition. For the black soils 24 sites were selected, 12 each for good and poor condition areas. A higher number were selected for the black soils as it makes up a larger proportion of the property.

Stratification is an important step when assessing satellite data for rangeland monitoring and validation with ground data (Graetz 1987, Friedel *et al.* 1993, Pickup *et al.* 2000). The site data were stratified between two pastorally significant landtypes upon the property – the limestone-calcareous red soils and the basaltic-derived black soils. Stratification was based on 1:100,000 landunit mapping of the property (McLeod and VanCuylenburg, in prep).

The mean values for the red and black soil landtypes were calculated within ERMapper in the red band (B1) and near-infra-red band (NIR) (B2). Mean values were also calculated for the sites and plotted.

RESULTS AND DISCUSSION

Initial results indicate that differences between areas of good and poor condition can be detected using MODIS 250m data. Of the 16 sites analysed for red soils and 24 for black soils, an average was calculated and used to plot good and poor areas on the time traces shown in Figure 1 and Figure 2.

From the time traces, differences between good and poor condition areas can be detected for each landtype. Differences in the time traces of the sites represent changes in cover levels, which become apparent towards the end of the dry season. NIR band data were also assessed but differences were less apparent in red soil compared with black soil landtypes. As a result further analysis with be performed upon this band.

Time traces of the landtypes and sites over a dry-wet season sequence highlight the complexities of monitoring vegetation cover in north Australia. During the wet season, January to April, vegetation cover is very high and green. Discriminating between areas of poor and good condition is very difficult due to high cover levels across the region. As the pastures begin to hay off and lose moisture content (greenness) differences between the sites become apparent.

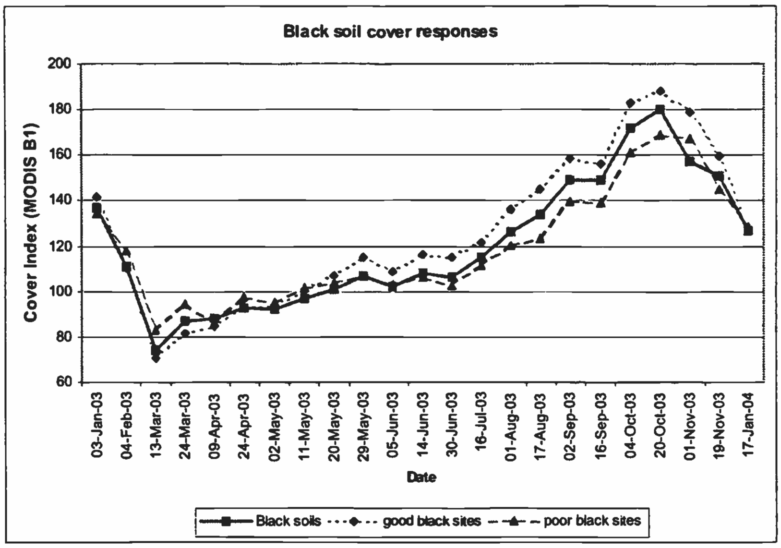

Figure 1. Time trace of the black soil landtype with poor and good sites. Discrimination between good and poor sites during the wet season is difficult due to high levels of green cover. As the dry season prevails and vegetation cover loses moisture content, differences between poor and good sites become apparent.

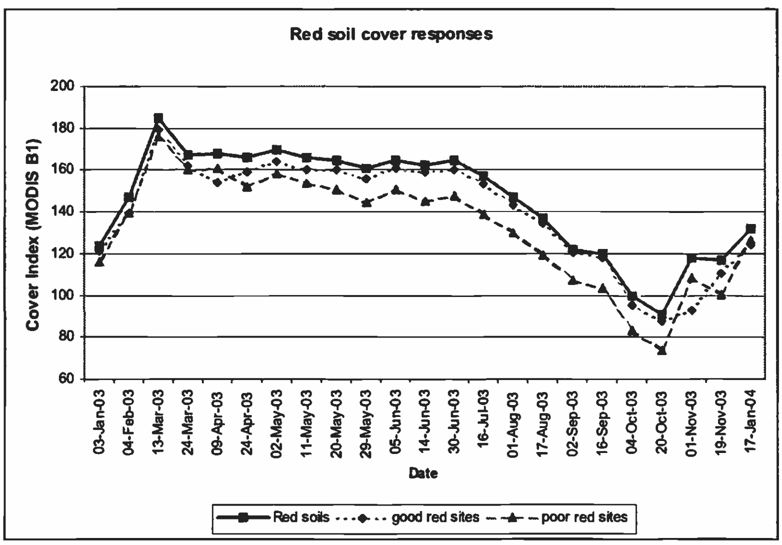

Figure 2. Time trace of red soil landtype with poor and good sites. Discrimination between good and poor sites during the wet season is difficult die to high levels of green cover. Separation between sites of varying condition is detectable as vegetation cover begins to hay off.

A *t*-test was performed upon the means of the samples from each set of sites for each date of MODIS imagery for the red band. It was found that good and poor sites were significantly different at the 0.05 significance level for half of the dates of the MODIS imagery.

For red soil sites these differences occurred earlier in the dry season than the black soil sites and ended earlier than the black soil types. This information can be used to assess the condition of areas throughout the season.

CONCLUSION

The project demonstrated that vegetation cover levels are able to be monitored using 250m MODIS data. Differences in condition could be detected upon red and black soil landtypes. Red band data were found to be effective in detecting changes in vegetation cover levels. Further advancement and application of 250m MODIS data would include extrapolating MODIS imagery to the wider VRD region and assessing other significant landtypes throughout the district.

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