MAPPING VERY POOR CONDITION GRAZED LANDSCAPES AT A REGIONAL SCALE – A REMOTE SENSING APPROACH

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INTRODUCTION

In recent years there has been recognition of, and importance placed on rehabilitation of the Australian landscape. Rehabilitation targets are being set by natural resource management (NRM) bodies across the country as outlined in the NRMMC (2002), with at least some emphasis being placed on the recovery or reclamation of very poor condition landscapes within each NRM region.

Monitoring and assessment of landscape condition is by no means a new idea, but until recently has been a tool primarily used and understood by scientific and extension communities. More recently however, the ABCD framework (Chilcott *et al.* 2003) for land condition assessment has emerged in North Queensland, and has gained wide acceptance at the ground level. Acceptance of the framework has led Queensland NRM bodies, particularly in the Great Barrier Reef (GBR) region, to use the framework to set rehabilitation targets. However, the location and area of those landscapes in very poor, (persistent low cover from a remote sensing perspective) or D-condition was not known.

The focus of this study is the grazing lands of the Burdekin catchment. It is the second largest catchment feeding into the GBR lagoon, covers some 133,432 square km and supports a wide variety of resource based land users including mining, horticulture and agriculture. The cattle industry is the largest land holder in the Burdekin catchment and represents around 96% of total land use (Greiner *et al.* 2003).

The Burdekin Dry Tropics NRM is interested in mapping D-condition areas of the grazed landscapes with an interest in prioritisation of investment, particularly with respect to degraded land rehabilitation. Due to the large area of interest and limited access to grazing properties the most efficient way to map poor condition land in the catchment is by using existing remotely sensed data.

Presented here is a method for mapping D-condition landscapes at a regional level.

METHODS

- Landsat TM (25m) imagery representing percent bare ground, or the Bare Ground Index (BGI), (Scarth et al., 2006) was provided by the Queensland government for the years spanning 1986 to 2006. The Burdekin catchment is covered by 14 Landsat scenes. BGI values were subtracted from 100 to provide a ground cover index (GCI). Foliage projected cover (FPC) >20% was used to mask woody vegetation in the imagery as high FPC greatly reduces the accuracy of ground cover estimation through pixel mixing. The most recent (2006) imagery was thresholded to indicate where areas of very low cover existed within the catchment, with cover <40% subsequently considered to be the level at which landscape condition and function tends to be degraded (McIvor et al, 1995; Corfield et al 2006). Panchromatic Spot 5 imagery (2.5m, supplied by the Burdekin Dry Tropics Board) was thresholded on pixel brightness to extract areas of bare ground or very low cover. The SPOT 5 bare ground classification was then used to refine and test GCI imagery thresholding.

- The 20yr span of the ground cover index allowed trend analysis of dry-season images (Wallace 1994). The trend analysis and long term cover means were used to derive the locations of longer-term, or more persistent, D-condition within the catchment.

- Ground truthing was carried out in September 2007 using PATCHKEY methods (Corfield et al., 2006) to measure the functional state of parallel transects >200m. PATCHKEY results could then be applied to the remote sensing (Abbott & Corfield 2006).

- Finally, Naïve Bayesian analysis of GIS and derived raster datasets containing biophysical data such as mean annual rainfall, grazing property size, land types and DEM derived indices (over 20 data layers in all) was carried out. To make data analysis tractable, layers were sampled using a 500 x 500 m point grid and imported into SQL server for analysis. Weighting was applied according to association strength (Bayesian node score) of the layer (Figure 2a) in relation to identified D-condition, and mapped into a GIS layer (figure 2b) using probability thresholds for occurrence of D-condition relative to each layer value. Mean annual rainfall, the strongest factor, was removed from the map output as the threshold value covered two thirds of the catchment and was seen as masking some of the smaller factors important to grazing land management.

RESULTS

The locations of both recent and longer term D condition are shown in Figure 1 where blue represents <40% ground cover in the 2006 dry season imagery and red represents long term D-condition as described by trend imagery.

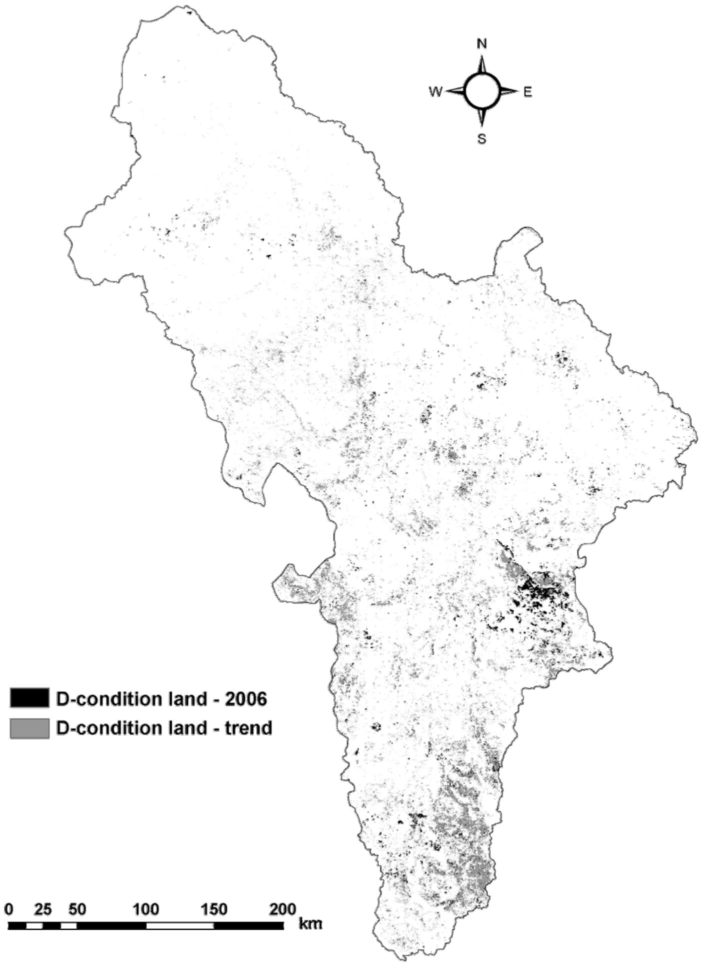

Figure 1: Map of D-condition land within the Burdekin catchment, showing the most recent assessment (2006 imagery) and long term D-condition landscapes derived from trend analysis.

Ground truthing results show a good fit between landscape function indicated by PATCHKEY derived at 25 ground sites throughout the catchment and the 2006 GCI image ($R^2 = 0.76$), even though there was a 12 month period between the image being taken and ground sampling. Figure 2b gives an indication of those landscapes vulnerable to becoming D-condition that occur in areas with high tree cover. These are areas that cannot be analysed directly from imagery alone. From the mapping it can be estimated that at the present time 7% of the catchment appears to be in D-condition with the possibility of another 7-10% being in, or susceptible to becoming D-condition.

(a) **(b)**

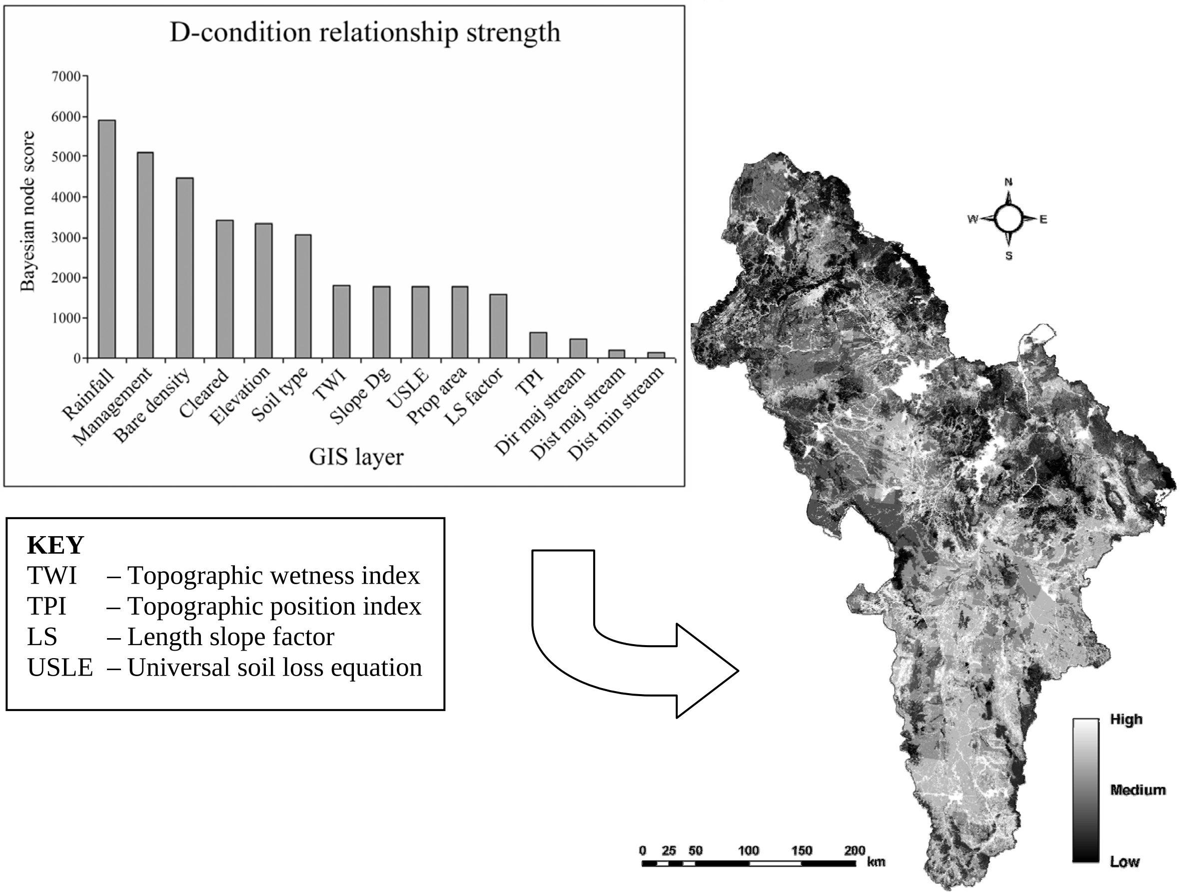

Figure 2: (a) Association strength of the fifteen highest ranking GIS layers with the mapped locations of D-condition landscapes. (b) Based on the associations in (a) and excluding rainfall, the predicted vulnerability of the entire Burdekin catchment becoming a D-condition landscape. White colour represents towns and large water bodies – removed from analysis as non grazed areas.

DISCUSSION

Mapping of D-condition land at a regional scale is possible as can be seen from the resultant map (figure 1). PATCHKEY validation of the <40% GCI threshold appears to be estimating cover levels fairly accurately. This is supported by the strong coefficient of determination between ground truthing data and the <40% GCI thresholded from the imagery, even though the images used for analysis pre-date the ground truthing by 12 months. Higher R^2 values would be expected for scenes matching the ground truth date. This expectation will be tested as BGI processed imagery becomes available.

There are some problems with mapping of D-condition areas however, and they are:

1) Mapping D-condition using a single image based on cover will only indicate those areas that have less than this cover level (e.g. <40%). These areas are not necessarily in D-condition because they will include areas experiencing short term or one-off change. For example, a short term grazing event may have occurred in an area of better condition, and this should not change underlying landscape condition or function. This is a typical problem associated with using a snapshot of cover as a surrogate for landscape condition. This limitation has been overcome by using cover as a landscape condition surrogate, but tying it to temporal effect. That is, looking at the change or trend in cover over time and how it relates to mean cover levels for any pixel. By using this method a much clearer picture of where D-condition is in the landscape can be achieved, and remove any single or unique

events that may have occurred. This is also true for any reduction in landscape function as it is known that a long term effect has been in place.

2) Tree canopy is a major problem with any remote sensed data when trying to estimate ground cover. Here areas with >20% tree canopy were masked from direct analysis of D condition. This threshold value is used by the Queensland State Government for specifying the tree layer and has also been used by others (e.g. Kitchin and Barson 1998). At this level, pixels containing ground and foliage cover are mixed and a higher threshold value is required to estimate D-condition land under trees. This process becomes arbitrary and problematic thus Bayesian modelling (based on probabilities) was used to infer D-condition in areas of high tree cover. The resultant map (Figure 2b) indicates the likely condition of a landscape or it's vulnerability to becoming D condition dependent on where D-condition occurs in relation to the other raster and GIS layers used. This method may be very important for NRM bodies in the future, as it is a way to target areas particularly for rehabilitation purposes. Other layers of possible relevance could be added to the analysis, e.g. those indicating biodiversity or production values.

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