# APPLICATION OF REMOTE SENSING (LANDSAT TM DATA) FOR VEGETATION PARAMETERS MEASUREMENT IN WESTERN DIVISION OF NSW

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**ABSTRACT**

The capability of Landsat (TM) data for vegetation parameters estimation was examined. Suitable vegetation indices were selected for arid and semi-arid areas. The possibility of accurate estimation of cover and yield of group of species was found.

**KEYWORDS**

Foliage cover, yield, biomass, vegetation index

**INTRODUCTION**

The capability of remote sensing for providing information on range condition and changes in cover and biomass was considered. But less attention has been given to the use of the Landsat Thematic Mapper (TM) data. Many researchers have developed and used transformations or vegetation indices based on band combinations in a variety of ways to evaluate vegetation parameters. An ideal vegetation index should have the characteristics of high sensitivity to vegetation, insensitivity to soil background changes and be only slightly affected by atmospheric path radiance Jackson *et al*. (1983). In the arid areas it should have the capability to sort out the effect of shadow and the influence of the large variety of leaf reflectances among the many species and groups of species found there, as well as standing dead vegetation and litter.

In remote sensing applications for the measurement of rangeland parameters, less attention was given to biomass estimation and also using Landsat Thematic Mapper (TM) data despite its more bands and its higher resolution. There were also no attempts to estimate vegetation parameters of groups of species, while the knowledge of vegetation components, especially perennials, is important to assess range condition and to determine utilisation levels. Therefore it was thought essential to further investigate selection or development of suitable vegetation indices and the possibility of accurate estimation of yield and cover in total and four major plant groups including perennial grasses, perennial and annual forbs and shrubs from Landsat TM images.

**MATERIALS AND METHODS**

Foliage cover, canopy cover and dry matter yield were measured. Data was collected on two separate occasions about 11-12 months apart from the 52 half metre square quadrats along four 300 metre parallel transects at Manuka (semi-arid) and 36-40 three metre square quadrats at Fowlers Gap (arid area). On the first occasion, the landscape was in drought (Jan. 1992), whereas, at the second time (Dec. 1992 or Jan. 1993) the vegetation was mostly green after drought breaking rains. Perennial grasses made up the principal components of vegetation cover on both occasions at Manuka, while the dominant species in the Sandstone paddock was bladder saltbush, and both bladder saltbush and blue bush in Conservation paddock. Images used in this study were obtained on 23th Dec. 1991 and 27th Feb. 1993 for Manuka, and 14th Feb. 1992 and 30th Dec. 1992 for Fowlers Gap (Landsat-5).

Several vegetation indices were tested to find the best index for the area of interest (Table 1). Correlations between vegetation parameters and vegetation indices were calculated to allow the determination of equations to estimate particular vegetation parameters. The reflectance values of each band of pixels related to sites and exclosures there were extracted from the images. Then reflectance data files in order of transect and quadrat were prepared for each image. After required corrections on images the field data and image of both occasions were added and matched together. Because of the errors involved with locating a ground sample to its relative pixel using co-ordinate measurement by GPS and converting these to the Australian Map Grid system, the means of ground samples along each transect were tested against means of the reflectance percentage of each band along that transect.

**RESULTS AND DISCUSSION**

At Manuka, the results showed highest correlations between total vegetation parameters, VNIR1 and VNIR2 ($P<0.001$). These indicated high reflectance in the near-infrared and low reflectance in the 0.4-0.6 mm part of the spectrum at the semi-arid site. Those vegetation indices that had higher correlations with total vegetation parameters had also high correlations with perennial grasses, with the same levels of significance. Vegetation indices with combinations of TM4 and TM3 bands had significant correlations with forb parameters.

The VNIR1 and VNIR2 indices which showed robust relationships with vegetation parameters in the semi-arid area, had lower correlations with vegetation parameters at the Conservation arid area site. In contrast, the NDVI index had a stronger correlation with vegetation parameters. Higher values of correlations also were obtained for NIR compared with the Manuka site. The PD321 ratio and PD322 vegetation indices showed no significant correlations with vegetation parameters. Due to the complexity of soil background that consisted of bare soil, red rock (14%) and white rock (1.3%), lower correlations between vegetation indices and vegetation parameters were expected for this site. The pasture layer yield consisted of ephemeral species with a very small contribution to total yield (biomass). The result showed higher correlation values between NIR, NDVI, PD312, biomass and shrub standing crop. Although the PD312 vegetation index had the highest SE and lower $R^2$ in the semi-arid area its $R^2$ and SE were highest and lowest respectively at the Conservation site. In contrast the VNIR1 index which was the best index in the semi-arid area in terms of the values of $R^2$ and SE, had no significant correlation with vegetation parameters in arid area sites. However the NDVI which was unable to predict either production or cover in a semi-arid area performed well in the chenopod communities. Despite lower correlations obtained for individual groups of species, the results indicated the possibility of estimating vegetation parameters for individual groups of species using satellite imagery.

For both cases of analysis, examination of equations showed that the error involved in vegetation parameters estimation was below the acceptable level. The results indicated the potential for accurate estimations of total and individual groups of species parameters including cover and biomass using Landsat TM data. The equations calculated in this research were derived from only two sets of data. To achieve the equations representative of most conditions that may occur in the region a longer period of data is required.

The procedures summarised below can be considered as a simple rangeland remote sensing analysis model which can be used elsewhere:

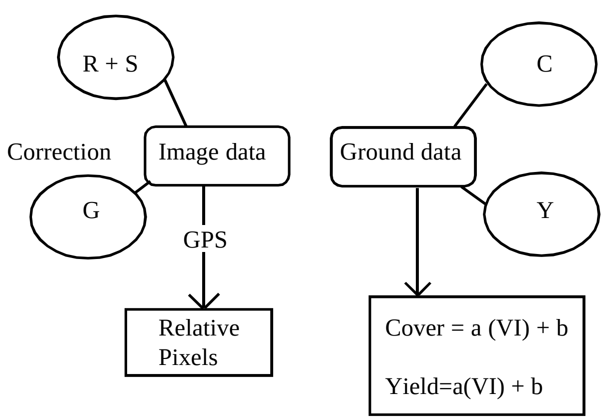
1. Providing a set of accurate ground data.
2. A selection of cloud free images closest to each time of field data collection.
3. Calibrating image data in terms of radiometric and geometric correction.

4. Determining rows and columns of image data corresponding to ground data.
5. Extracting image data related to the ground data from the images.
6. Preparing a data file of image data with the same structure as the field data.
7. Combining images of different times and calculating vegetation indices.
8. Matching ground data and vegetation indices for further analysis.
9. Analysing data for correlation between vegetation indices and related vegetation parameters and selecting the most reliable indices that suit a particular land system.
10. Calculating equations for estimating each vegetation parameter.
11. Testing equations in similar vegetation types for future use.
The procedures can be illustrated in Figure 1.

**Table 1**
Vegetation indices tested in this study.

| Index | Band Formula |
|---|---|
| Near-infrared/red ratio (NIR) | TM4/TM3 |
| Moisture stress index (MSI) | TM5/TM4 |
| Leaf water content (Mid-IR. index) MIR | TM5/TM7 |
| Contrast reflectance in visible and near-infrared (VNIR1) | (TM4-TM1)/(TM4+TM1) |
| VNIR2 | (TM4-TM2)/(TM4+TM2) |
| Normalised difference veg. ind. (NDVI) | (TM4-TM3)/(TM4+TM3) |
| Transformed veg. index (TVI) | (TM4-TM3)/(TM4+TM3)+0.5 |
| Infrared index (IR) | (TM4-TM5)/(TM4+TM5) |
| IR2 | (TM4-TM7)/(TM4+TM7) |
| Reflectance absorption index (RA) | TM4/(TM3+TM5) |
| Modified normalised difference (MND) | (TM4-(1.2 X TM3))/(TM4+TM3) |
| PD321 | TM3-TM2 |
| PD311 | TM3-TM1 |
| PD322 | (TM3-TM2)/(TM3+TM2) |
| PD312 | (TM3-TM1)/(TM3+TM1) |
| MINI | (TM7-TM4)/(TM7+TM4) |
| MIRV1 | (TM7-TM3)/(TM7+TM3) |
| MIRV2 | (TM5-TM3)/(TM5+TM3) |

**Figure 1**
Model for estimating cover and yield from Landsat TM data




R + s = radiometric and soil background correction    C = cover measurement (%)

G = geometric correction    Y = dry matter yield measurement

VI = vegetation index    (kg/ha)

**REFERENCES**

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