# Estimating Pasture Land Cover in the New England Region of Northern New South Wales

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## Introduction

Land cover across the southern Australian temperate agricultural region comprises primarily of native pasture, introduced improved pastures and crops for livestock production and also perennial remnant vegetation. A feed-base pasture audit was carried out throughout southern Australia commencing mid-year 2011 (Donald and Burge 2012; Donald *et al*. 2012). The purpose of the audit was to map and analyse information obtained about the pasture feed-base for livestock production by surveying Statistical Local Areas (SLAs) across the southern states. The purpose of this Feed-Base audit was to survey pastures within agricultural NSW, Victoria, Tasmania, South Australia and South-Western Australia, collate these data into an organised database, and prepare a short report and summarise by tabulating and mapping pasture species abundance and distribution. Data collected were based on "desk-top estimates" by state district agronomists and agricultural consultants. In this paper a method using satellite imagery is described on how more objective assessments of pasture types can be provided as a means to discriminate between the SLA's major pasture classes far more objectively than by visual assessment. Satellite remote sensing may be used to define landcover classes for large regional areas. A number of procedures have been developed to discriminate between pastures, crop and woody vegetation (for example Hill *et al.* 1997, Emelyanova *et al.* 2008). In the Hill study (Hill *et al*. 1997) NOAA AVHRR NDVI provided spatial land cover maps of pasture cover at 1 km resolution. The classifications results in that study showed that satellite information may be used to help in the interpretation of pasture survey results, and in turn, the survey data can provide some validation data for the pasture types ascribed to the remotely sensed classes.

In this study daily temporal continental scale imagery from 250m$^2$ resolution TERRA and AQUA satellite Moderate Resolution Imaging Spectroradiometer (MODIS) normalised difference vegetation index (NDVI) composited into weekly continental images provided a means to assess temporal profile of spectral greenness over the growing season.

## Method

In order to relate the survey data to the classifications, we need to define the possible level of discrimination between pasture types based on greenness. In this study six SLA's were selected covering the Northern NSW tablelands (Fig. 1) as pastures within these SLA's are perennial, since this is a summer rainfall area with very cold, frosty winters. Annual legumes and crop content are not important or trivial in content. The major species are improved perennial legumes and grasses, and native perennial grasses. Native grass-based pastures predominate, but many were oversown with white clover at some stage during the last 40 years. The most heavily cleared areas are likely to be the most developed and to have the highest levels of improved pasture. The wooded areas are more likely to be dominated by native pasture with or without some white clover and fertiliser use. Hence, all pastures except unimproved native could have significant greenness in spring-summer, but only semi-improved or improved pastures will still be green in autumn and winter since native pasture is usually heavily frost affected.

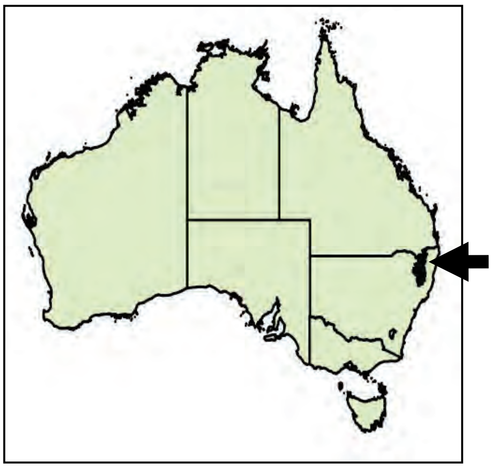

**Figure 1. Location of the Northern NSW Statistical Local Areas.**

This variation of spatial pattern of seasonal greenness provides a means to distinguish land cover classes. Weekly MODIS NDVI satellite imagery covering this region was provided by Landgate Satellite Remote Sensing, Floreat, Western Australia. It must be emphasized that the low resolution classification of 250 m$^2$ pixel contains a mixture of pasture types and that the classification can only indicate reliably the proportion of improved versus native types. Further partition of pastures required ground "truthing"

**Table 1. Percentage of each major class within the SLA.**

| SLA | Dumaresq | | Glen Innes | | Uralla | | Walcha | | Inverell | | Guyra | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pasture | Audit (%) | Satellite (%) | Audit (%) | Satellite (%) | Audit (%) | Satellite (%) | Audit (%) | Satellite (%) | Audit (%) | Satellite (%) | Audit (%) | Satellite (%) |
| Introduced | 53 | 58 | 46 | 55 | 43 | 31 | 52 | 60 | 45 | 40 | 55 | 69 |
| Native | 18 | 23 | 42 | 27 | 48 | 68 | 35 | 14 | 33 | 50 | 36 | 27 |
| Other | 29 | 19 | 12 | 18 | 9 | 1 | 13 | 26 | 21 | 10 | 9 | 4 |

including elementary "end member" analysis. The process included the examination of the various pasture class profiles and their areas and comparison of these areas with the relative estimates of percentage area for perennial grass-based pastures from the survey. We assumed that the greenest classes have the highest proportion of improved pasture and the less green classes the lowest proportion. The 2011 weekly MODIS NDVI images were subjected to a clustering procedure within ARCGIS (ESRI, Sydney) followed by an unsupervised maximum likelihood classification procedure as a means to discriminate between land cover classes. The derived spatial classes were identified and grouped into either introduced improved pastures, native pastures or other including woody scrub and other perennial woody vegetation.

## Results

The areas of each were expressed as percentage of SLA content (Table 1). The mean MODIS NDVI profile of the each pasture reflects the seasonal changes in spatial patterns of landscape NDVI as a time series and confirms the discrimination of the pasture classes.

For example, the audit data for Dumaresq suggest that about 53% of the SLA area is improved, and 18% of the SLA area is native pasture, some of which is unimproved, some fertilised and oversown with legumes with 29% as perennial woody vegetation compared to 58%, 23% and 19% respectively for satellite derived estimates. The area of pastured land for the audit is derived from ABS data collated from farmer surveys

## Conclusion

The weekly MODIS NDVI pasture profile shows a marked spring-summer greening wave compared with the native pasture and forest. This example of integrating different sources of information to enhance interpretation depends on assumptions about the association of pasture type with greenness patterns, and assumptions about the accuracy of the survey area estimates. The analysis lends itself to a probabilistic rather than a deterministic interpretation as the comparison presented here is between subjective surveyed information and objectively produced satellite data, both having their own level of reliability. This simple procedure was designed initially to provide an objective means to partition pasture into major classes within the southern Australian Meat Livestock Australian livestock 402 feed-base SLA's. Further discrimination requires additional field information. Also, the process could operate within existing internet pasture biomass and pasture growth rate delivery products as a means to differentiate between pastured land and those lands exhibiting native and improved pasture.

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