

ABSTRACT

The Savanna biome covers around 60% of sub-Saharan Africa. The goods and services it provides are utilised and often depended upon by rural communities, commercial farmers and managers of conservation areas existing within it. The benefits derivable by these parties depend largely on vegetation structure and species composition which can show great variation within savannas. Fire has long been used as an effective means of manipulating savanna vegetation to maximise the provision of specific benefits, usually the provision of new herbaceous growth, and to a lesser extent to control woody cover. Information on the abundance and distribution of herbaceous biomass, which is the primary fuel source for savanna fires, has emerged as one of the most important inputs for savanna management planning. Although the most popular and reliable means of obtaining this information remains field-based sampling, estimation using remote sensing data is increasingly being incorporated into the process. Its increased popularity stems from the fact that it can greatly expand the extent of the areas for which herbaceous biomass estimations can be provided.

Although there have been studies conducted on the performance of individual remote sensing based herbaceous biomass estimation methods, few have focused on the relative performance of available methods. Information on the accuracy of methods when applied in relatively densely wooded savannas, or those where a large amount of herbaceous material is retained between seasons is also limited. This presents a problem for savanna managers in South Africa where these conditions prevail. It was the aim of this study to compare the accuracy and precision of two different remote sensing based herbaceous biomass estimation techniques (the use of a regression model and cokriging) when applied under such conditions.

To achieve this aim a large amount of herbaceous biomass data were required to form testing and training datasets. These were acquired from

the Kruger National Park's Veld Condition Assessment (VCA) datasets for the growth seasons between 2000 and 2006, which contains herbaceous biomass estimates based on disk pasture meter readings. It was suspected early on in the study that the VCA field data was not ideal for use as remote sensing (ground truthing) field data because of the limited size of the field plots relative to the pixels of the remotely sensed imagery used. It was decided to include an additional section of analysis to determine the possible contribution of this issue to the estimation error of the methods assessed. This involved measuring and comparing mean herbaceous biomass in co-located trial 60x60m VCA sites and trial 250x250m, The Moderate Resolution Imaging Spectroradiometer (MODIS) pixels.

The main section of analysis involved (i) gathering and deriving the required variables for use in the two estimation methods assessed, (ii) producing the estimates and (iii) comparing their accuracy and precision. The first method assessed was the use of a linear regression model. Seven regression models were created in total, one for each year of the growth seasons occurring between 2000 and 2006, plus another using all of the data combined. The models included variables to account for vegetation production (based on MODIS EVI), tree cover and fire history. These variables were derived using data supplied by the CSIR and Kruger National Park Scientific Services. The second method assessed was cokriging performed with the VCA herbaceous biomass field estimates as the primary variable and the MODIS EVI data as a secondary variable.

The regression models were unable to account for more than 46% of the variation in herbaceous biomass, usually accounting for between just 20 and 30% (R^2 of between 0.2 and 0.3). Three potential methods were identified that could improve the model fits obtained in the future, namely:

1. Increasing the dimensions of the field sample plots
2. Improving the calibration of the disk pasture meter used to collect the field data

3. Using EVI from previous seasons in conjunction with fire scar data to account for the presence of dry material from previous seasons.

Cokriging produced estimates that were on average 119 kg/ha more accurate than those of the regression models. However, the performance of cokriging was poorer than expected given the results of previous studies in the area. A possible explanation for this discrepancy is that the ArcGIS geostatistical analysis extension used in this study is limited in its capabilities. Even with the poorer than expected performance recorded in this study, the cokriged maps remain the best option for fire managers as they are the most accurate to date and require the fewest resources to produce. Neither method produced estimates with less than 1000 kg/ha of error (RMSE), the upper limit initially considered useful in this study. However this error limit could be considered unrealistic given the well documented high level of heterogeneity typical of southern African savannas.