INTEGRATION OF REMOTE SENSING AND ANCILLARY DATA TO DESCRIBE THE PHYSIOLOGICAL STATE OF *EUCALYPTUS GRANDIS* PLANTATION

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ABSTRACT

The state (type, structure and biochemical content or vitality) of natural and agro-ecosystems are influenced by several factors including available nutrients, soil types, and topographic and climatic factors. In other words, foliar biochemicals (e.g. chlorophyll, Nitrogen) for example may provide information on the factors controlling growth and productivity of ecosystems. However, the quantification of foliar biochemicals is difficult for scales beyond forest stands, e.g. at regional scales. In this regards, remote sensing has been exploited as a time and cost-effective alternative to intensive field surveys in assessing ecosystem state over broad areas. However, reported estimation accuracies are low, particularly for subtle differences in foliar biochemicals. In this study, we assess the importance of *in situ* explanatory variables (e.g. digital elevation model's derived products such as altitude, aspects, slopes and solar radiation, and total available water) in remote sensing of an even-aged (8 year old) *Eucalyptus grandis* state variable (foliar chlorophyll content) through an integrated approach i.e. using remote sensing and *in situ* variables as explanatory or independent variables to predict foliar chlorophyll content. The study was conducted in *E. grandis* plantation stands of Mondi S.A.in KwaZulu-Natal, South Africa.

Leaf chlorophyll content was measured using the chlorophyll-meter, SPAD. Both leaf and canopy level spectral measurements were made using an ASD spectroradiometer (FieldSpec3 Pro FR, Analytical spectral Device, Inc, USA) in the 350-2500 nm range,

for 65 trees at 19 locations. The sites were located in three soil quality types (poor, medium and good) as determined by total available water (TAW). Other ancillary data such as elevation, aspect, slope and the average annual incident solar radiation were derived from the digital elevation model of the study site. The research method consisted of first investigating the performance of regression models derived from remote sensing or in situ data only and subsequently assessing if the integration of the two data types improved the estimation of leaf chlorophyll content.

Here we report the results of leaf level investigations. The best spectral-chlorophyll index, the red-edge position accounted for 39% of the variance in SPAD readings, while latent variables (principal components) derived from the ancillary data explained 6% of the variance in SPAD readings. An integration of the two data sets through multiple regression showed an increase in the explained variance to 45% ($p<0.05$). These results are significant given the subtle differences or low variability in the SPAD readings (range = 41.4-56.3, standard deviation = 3.3) for the study site. The study thus demonstrated that the integration of remote sensing and *in situ* data could be important in providing more accurate estimates of *E. grandis* state in KwaZulu Natal, South Africa compared to remote sensing only models. Such modelling effort would become important at the regional scale in the near future as space-borne imaging spectroscopy or hyperspectral sensors become more available.