SYNERGISTIC USE OF MULTI-SENSOR DATA FOR ESTIMATING THE ABOVE-GROUND BIOMASS OF AFRICA

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1. INTRODUCTION

Large area routine mapping and monitoring of carbon stocks has frequently been regarded as beyond the current capability of satellite remote sensing technology, partly because most of the research on stock mapping has focused on field sampling approaches. Nonetheless, mapping carbon stocks over large areas without satellite data is clearly problematic. We revisited the potential for satellites to measure carbon stocks, defined as half of above ground biomass (AGB), focusing on Africa as a case study. Africa is unique in that it contains the second largest block of rainforest in the world, next to the Amazon basin, but is the least known in terms of carbon stocks and rates of forest conversion. The existing biomass estimates are derived from national forest inventories that provide accurate estimates at national or plot level, but less accurate in providing information on the spatial distribution of AGB. Furthermore, few countries in Africa have forest inventories and many are obsolete.

2. METHODS

We focused primary on use of optical imagery combined with lidar sampling, but also explored a more localized case study using the Japanese Advanced Land Observing Satellite (ALOS) and Landsat imagery. Whereas optical measurements have been widely used in studies that link AGB measurements from the field to satellite observations, these have not proven to be consistent over large areas because surface conditions change more rapidly than the repeat time of the cloud-free satellite observations, producing artifacts in the derived maps. We overcome this limitation using frequent repeat measurements from the Moderate Resolution Imaging Sensors (MODIS) onboard the AQUA and TERRA satellites. We generated a best-quality cloud-free mosaic of MODIS satellite reflectance observations for the period 2000–2003 and used a regression tree model to predict AGB at 1 km resolution [1]. Field biomass data sets were derived from quality-checked forest inventories carried out in Congo, Cameroon and Uganda. The forest inventories provided timber volume or biomass information at the plot level, or as averages associated with specific vegetation types. Because of time differences between field data collection and MODIS observations, the MODIS pixels used for the analysis were screened using high-resolution orthorectified Landsat GeoCover imagery to verify that major land cover transitions had not occurred in the interim.

3. RESULTS

Results based on a cross-validation approach show that the model explained 82% of the variance in AGB, with a root mean square error of 50.5 Mg ha^{-1} for a range of biomass between 0 and 454 Mg ha^{-1}. Analysis of lidar metrics from the Geoscience Laser Altimetry System (GLAS), which are sensitive to vegetation structure, indicate that the model successfully captured the regional distribution of AGB. The results showed a strong positive correlation (R^2 = 0.90) between the GLAS height metrics and predicted AGB. We are now refining the analysis with 500m observations, extending the time and spatial domains, and using the ALOS and GLAS metrics in a more synergistic manner. We will report on these synergistic cases studies as well. We conclude with a brief review a range of approaches that have been developed and used to map carbon stocks across a diverse set of conditions and geographic areas, and where the science is going with the advent of new satellite missions.

4. REFERENCES

[1] A.Baccini, N.T. Laporte, S.J. Goetz, M. Sun, and H. Dong, H. “A first map of tropical Africa's above-ground biomass derived from satellite imagery,” *Environmental Research Letters, 045011* Online journal: stacks.iop.org/1748-9326, Dec. 2008.