Abstract for IGARSS 2009 Conference – Invited session: Forest resources of Africa'

Detecting changes of woody biomass in four African forest-savanna landscapes using multi-temporal L-band SAR

Authors: **E.T.A. Mitchard[a,e], S.S. Saatchi[b], P. Meir[a], I.H. Woodhouse[a], L. White[c] & K. Abernethy[d]**

[a] *School of Geosciences, University of Edinburgh, EH8 9XP, UK*
[b] *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA*
c Gabon Delegation to UNFCCC, 250 Blvd. Quaben, BP 7847, Libreville, Gabon
[d] *Biological Sciences, University of Stirling, Stirling, FK9 4LA, UK*
[e] *edward.mitchard@ed.ac.uk*

Satellite-derived L-band SAR data collected by the JERS-1 and ALOS PALSAR instruments in the mid-1990s and 2007/8 respectively have been compared at four locations in Africa to detect changes in above-ground woody biomass. These are large areas (5000 – 15000 km^2) covering a mosaic of forest and savanna including and surrounding the Mbam Djerem National Park in central Cameroon, Lopé National Park in Gabon, Budongo Forest in Uganda, and the miombo woodlands of central Mozambique. Tree structure and composition from a number of plots and transects were collected for all sites in 2007/8, close in time to the ALOS data acquisition. Above-ground biomass at each plot was calculated for all trees greater than 10 cm DBH (Diameter at 1.3 m height) using tropical dry/moist forest allometry. Ground measurements of changes in biomass were possible using permanent plots in two of the study areas. For Budongo historical field data exists for five 1.86 hectare plots set up in the 1930s, and remeasured at various points since, most recently 1993, and for Lopé five 5 km x 20 m transects and c. 200 small plots were first measured in the early- and mid- 1990s, and have been remeasured more recently. For the other two sites no historical field data existed to calibrate the JERS-1 data, so a novel back-calibration method involving suspected unchanged areas was successfully used.

Good relationships between backscatter and woody biomass were found in all four locations, despite the marked differences in vegetation type, climate and the wide geographical separation. The relationships between woody biomass and backscatter found were site-specific, and showed a variable saturation point, always higher for HV (cross-polarised) PALSAR data than the corresponding JERS-1 HH data. Both deforestation/degradation of forests and woody encroachment of savannas were detected with confidence using this methodology. Comparison with the field data and the expert knowledge of the sites allowed a careful analysis of the errors and uncertainties involved in the change detection approach.

A rapid increase in biomass was found in much of the woodland/savanna areas of all four locations. This woody encroachment appears to be linked to a reduction in fire frequency, putatively caused by a reduction in human influences in these areas. Similar changes have also been found in drier savannas of Africa, and if this increase is widespread it would have important consequences for habitat and species diversity, as well as for the carbon cycle.

Bibliography

Eamus, D., & Palmer, A. R. (2007) Is climate change a possible explanation for woody thickening in arid and semi-arid regions?. *Research Letters in Ecology*. Vol. 2007. Article ID 37364.

Guillet, B., Achoundong, G., Happi, J.Y., Beyala, V. K. K., Bonvallot, J., Riera, B., Mariotti, A., & Schwartz, D. (2001) Agreement between floristic and soil organic carbon isotope ($^{13}C/^{12}C$, ^{14}C) indicators of forest invasion of savannas during the last century in Cameroon. *Journal of Tropical Ecology*, Vol. 17, pp. 809-832.

Mitchard, E.T.A., Saatchi, S.S., Woodhouse, I.H., Feldpausch, T.R., Lewis, S.L., Sonké, B., Rowland, C., & Meir, P. (In review). Measuring biomass changes from woody encroachment and deforestation in the forest-savanna boundary region of central Africa from multi-temporal L-band radar backscatter. *JGR Biogeosciences.*

Mitchard, E.T.A., Saatchi, S. S., Gerard, F. F., Lewis, S. L., & Meir, P. (In review). Detecting Woody Encroachment from 1986-2006 along a Forest-Savanna Boundary in Central Cameroon. *Earth Interactions.*

Sano, E. E., Ferreira, L. G., & Huete, A. R. (2005) Synthetic aperature radar (L-band) and optical vegetation indices for discriminating the Brazilian savanna physiognomies: a comparative analysis. *Earth Interactions*, Vol. 9. pp. 1-15.

Santos, J. R., Pardi Lacruz, M. S., Araujo, L. S., & Keil, M. (2002) Savanna and tropical rainforest biomass estimation and spatialization using JERS- 1 data. *International Journal of Remote Sensing*, Vol. 23. pp. 1217-1229.

Williams M., Ryan, C.M., Rees, R.M., Sambane, E., Fernando, J., & Grace, J. (2008) Carbon sequestration and biodiversity of re-growing miombo woodlands in Mozambique, *Forest Ecology and Management,* Vol. 254. pp. 145-155.