BACKSCATTER AND INTERFEROMETRY FOR ESTIMATING ABOVE-GROUND BIOMASS OF SPARSE WOODLAND: A CASE STUDY IN BELIZE

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Although use of radar for biomass estimation has been widely investigated for temperate forests (usually managed), boreal forests and tropical rainforests, tropical savanna woodlands have been largely neglected in biomass studies ([1] and [2] are a few examples). Sparse woodlands such as those that occur in Belizean savannas are a challenge for radar remote sensing methods: long-wave backscatter is dominated not only by high biomass areas, but by areas of leafy palmettos which have low vegetative biomass [3] and canopy height estimation using single-pass shortwave interferometry is affected by the sparse and heterogeneous nature of savanna woodlands. Canopy height estimations can be used to estimate above-ground biomass using allometric equations based on tree height. In this paper we present backscatter-biomass results for L- and P-band for the savanna woodlands and compare results for X-band and C-band data at 5 m posting for savanna woodland canopy height estimations. Furthermore, we assess the potential for using such methods for global savanna biomass estimation using ALOS PALSAR and TanDEM-X data.

This study therefore fills a significant knowledge gap in the context of global biomass mapping for carbon cycle studies. Tropical savannas cover approximately 40% of the tropics, which amounts to 15% of the Earth's land surface. They form highly productive ecosystems and therefore have enormous potential for carbon sequestration. These productivity rates were previously unappreciated. Because of easier accessibility than for tropical forests, population pressure in tropical savannas is high and land use changes occur more rapidly, particularly since most of the world's savannas occur in developing countries. Degradation is caused by regular burning, cultivation and herbivory.

In the light of their sensitive nature and the Kyoto Protocol, where governments could in future earn revenues for maintaining and conserving natural carbon sinks, it is imperative to develop accurate and precise methods for estimating vegetative biomass. Given the high costs, labour intensity and sometimes destructive means of measuring biomass directly by field methods, remote sensing has great potential to provide cost-effective and timely biomass estimates over large areas. Radar remote sensing has an advantage over optical remote sensing in the tropics as it is not affected by cloud cover, which is common over the tropics.

This paper evaluates the capability of long wave SAR backscatter and short wave SAR interferometry (InSAR) for estimating above-ground biomass of the woody vegetation in heterogeneous tropical savanna woodland. Radar data available to the project are fully polarimetric AirSAR L- and P-band backscatter, and C-band single-pass InSAR (March 2004), Intermap Technologies STAR-3i X-band InSAR data (April 1999) and a substantial set of field data comprising a transect of 800 m x 60 m spanning the main savanna vegetation strata occurring in the study area in Belize, Central America (April/May 2005). The latter consists of three-dimensional measurements of 1044 trees. Results show that L- and P-band backscatter is strongly affected by low biomass palmetto vegetation. Furthermore, InSAR-retrieved canopy heights from X- and C-band are indicative of general patterns of tree height, but the details remain inaccurate due to the heterogeneity of the canopy. Interestingly, scattering phase centers for C-band are generally higher than for X-band over sparse woodlands, whereas dense tropical forest areas yield higher X-band scattering phase centers.

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