RETRIEVING TREE HEIGHTS IN AFRICAN SAVANNA WOODLANDS USING THREE STAGE SINC INVERSION

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Abstract

African savanna woodlands have an unpredictable spatial and temporal variability of woody biomass densities as a result of the interplay of rainfall, soil nutrients, fire, people and herbivores. These woodlands are characterised by heterogeneous species distribution with irregular vertical structures. A large percentage of rural communities in southern Africa rely on communal woodlands to meet their domestic energy demand and supply requirements [1]. Fuelwood and charcoal are the predominant sources of bioenergy in most low-income rural and urban households. Although the woodlands play such a critical role in the energy sector, no landscape studies have been undertaken to estimate the accessible woody biomass resources. There is a paucity of quantitative data on available woody biomass resources to provide critical input into energy planning models at the landscape level.

The average woody biomass density in subtropical savanna woodlands is around 70 t ha^{-1} [2, 3], which is below the saturation point of current spaceborne radar remote sensing platforms [4]. A number of vertical height retrieval methods have been tested in boreal, temperate and tropical forests [4-6] but very few SAR studies have focused on subtropical savanna woodlands. This paper presents an attempt to implement the Random-Volume-over-Ground (RVoG) model to retrieve tree heights in savanna woodlands for subsequent conversion to standing biomass quantities. Tree heights will be retrieved from SAR data using the two-layer vegetation polarimetric SAR interferometry (POLInSAR) model outlined in [4, 7] and extended for Three Stage SINC (TSS) inversion in [8]. This method does not require *a priori* knowledge of the reference digital elevation model (DEM). High resolution digital elevation models are not readily available in most rural areas in southern Africa. TSS involves estimation of the ground phase using the Least Squares intersection of the inversion model with the unit circle. The second stage calculates the reference ground phase using the initial ground phase values from the first stage. A coherence ranking order algorithm is employed to select the volumetric coherence [8]. The volumetric coherence estimate from the second stage is inputted into the SINC function for computing the tree height. Full polarimetric ALOS PALSAR data for selected case study areas in South Africa, Mozambique and Zambia will be used for the height retrieval analysis. Ground-truthing surveys will be carried out along transects in selected training sites using the conventional point-center-quarter (PCQ) method [9] to measure tree heights and diameters at ankle

height. The vertical structure of most trees found in savanna makes it impractical to measure diameter at breast height for biomass estimations [10]. Field data will be used to validate the heights retrieved from the polarimetric SAR interferometry inversion [8]. Woody biomass estimates will be calculated using existing allometric equations for subtropical savanna woodlands.

The influence of sparse canopy density, species heterogeneity and variable vertical structure will be investigated to derive ways of compensating for errors inherent from such irregularities. The retrieved heights will converted to above-ground biomass quantities through allometric relationships. The quantitative data on woody biomass resources will constitute essential input into energy, woodland dynamics and socio-economic models to plan and manage fuelwood extraction in communal areas in rural southern Africa.

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