# Chapter 54
# Estimating Potential Woody Biomass in Communal Savanna Woodlands from Synthetic Aperture Radar (SAR)

**Charles Paradzayi**
*University of Johannesburg, South Africa & Midlands State University, Zimbabwe*

**Harold J. Annegarn**
*University of Johannesburg, South Africa*

## ABSTRACT

*Recent developments in Synthetic Aperture Radar (SAR) technologies have shown their potential for assessing and quantifying above-ground biomass (AGB) at landscape levels in different biomes. This paper examines the application of full polarimetric data to retrieve information related to potential woody biomass in sparse communal savanna woodlands in southern Africa using the Advanced Land Observation Satellite's Phased Array L-band Synthetic Aperture Radar (ALOS PALSAR). Woody vegetation classes were obtained from the unsupervised entropy/alpha Wishart classification of the full polarimetric ALOS/PALSAR data. A combination of Differential GPS and conventional surveying techniques was used for a field inventory survey to estimate plot-level biomass densities in Welverdiend communal woodlands of South Africa. Regression analysis was used to derive the logarithmic relationship between the sampled plot AGB densities and the mean backscatter intensity of the microwave signal, which is transmitted in the horizontal plane and received in the vertical plane (HV). The AGB density for each woody vegetation class is estimated by solving the logarithmic equation after extracting the mean HV backscatter intensity for the particular vegetation class. The potential woody biomass is estimated from the derived AGB densities and the areal extent of the respective woody vegetation classes.*

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## INTRODUCTION

Population growth and persistent poverty are increasing pressure on forest and woodland resources, thereby threatening their sustainable utilisation. In some electrified communities, the high cost of electricity has generally prevented a move away from dependency on bio-energy (Madubansi & Shackleton, 2007). At the same time, intensive harvesting practices and demands for arable farming land are contributing to the continued decrease in the availability of tree species preferred for fuelwood and/or charcoal. Indicators of energy poverty such as increased distance of preferred species from households are beginning to emerge in certain communal woodlands that are not subject to rigorous management regimes (Howells et al., 2003; Madubansi & Shackleton, 2007). This is resulting in the emergence of both micro- and macro-level woody biomass trading within and among villages, and from rural to urban areas respectively. In Mozambique, Tanzania and Zambia, charcoal from communal woodlands is exported to urban centres for sale to low-income urban dwellers. However, there is a general paucity of quantitative data on available woody biomass resources to provide critical input into energy planning models at the landscape level in most rural economies (Mabowe, 2006). The objective of this paper is to investigate the potential of using the intensity of the backscatter signal of polarimetric synthetic aperture radar to quantify above ground biomass density and then map the spatial distribution of available above ground biomass resources in savanna woodlands.

### Utilisation of Woody Biomass Resources in Low-Income Communities

Savanna woodlands provide a traditional source of woody biomass and other non-timber forestry products for a large percentage of households in both rural and urban low-income communities in southern Africa (Scholes & Archer, 1997; Twine, Moshe, Netshiluvhi, & Siphugu, 2003; Whitlow, 1979). The predominant source of bioenergy in most low-income rural and urban households is woody biomass in the form of charcoal and fuelwood (Banks, Griffin, Shackleton, Shackleton, & Mavrandonis, 1996; Wamukonya & Jerkins, 1995). In Mozambique, biomass (charcoal and firewood) provides up to 80% of energy consumption while 87% of rural households in Zambia use fuelwood for cooking (Brouwer & Falcão, 2004; Chidumayo, Masialeti, Ntalasha, & Kalumiana, 2002). Quantitative information about available biomass resources required to meet domestic energy demands is lacking in most developing economies. In addition, quantitative information on woody biomass resources is becoming critical for national inventories of woody biomass stocks for carbon sequestration and accounting purposes as well as for meeting the reporting requirements for international conventions and protocols such as the *Kyoto Protocol on Climate Change* and the *Reduction of Emissions from Deforestation and forest Degradation* (REDD) initiatives (Gibbs, Brown, Niles, & Foley, 2007; Woodhouse, Cassells, Mitchard, & Tembo, 2009).

### Biomass Estimation in Savanna Woodlands

Conventional field inventory and optical remote sensing approaches have been used in the past to estimate available above ground biomass (Chidumayo, 1997; Ellegård, Chidumayo, Malimbwi, Pereira, & Voss, 2002; Grundy, 1995). Field inventory measurements provide essential data for validating remotely sensed biomass estimates. However, such approaches are tedious and time-consuming. They are also constrained by accessibility problems, thus limiting the sampling approaches to areas where measuring equipment can be delivered (JICA, 2005; Mabowe, 2006; Netshiluvhi & Scholes, 2001). In savanna woodlands, allometric equations relating measurable

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