The use of Polarimetric AIRSAR (POLSAR) data for characterising mangrove communities.

R.M. Lucas[1] , A. Mitchell[2], and C. Proisy[3]

[1]Institute of Geography and Earth Sciences, The University of Wales, Aberystwyth, Aberystwyth, Ceredigion, SY23 3DB, United Kingdom (rml@aber.ac.uk)
[2]School of Geography, The University of New South Wales, Kensington, NSW, 2052, Australia
[3] Regional Laboratory of Remote Sensing, Institute of Research for Development (IRD), Route de Montabo, BP 165, 97323 Cayenne cedex, French Guiana.

INTRODUCTION

Mougin *et al.* (1999) and Proisy *et al*. (2001, 2002) demonstrated, through observation and simulation, the capacity of Synthetic Aperture Radar (SAR) for quantifying the biomass and structure of mangroves in French Guiana. In this preliminary study, we aimed to establish whether similar backscatter characteristics were observed for mangroves in northern Australia. AIRSAR data were acquired for the French Guiana and northern Australian mangroves in 1993 and 1996 respectively.

COMPARISON OF STUDY AREAS

Alligator Rivers Region (ARR), Kakadu N.P., Northern Australia: The mangroves of the ARR occur in narrow fringes that are generally confined to the channel banks and edges of tidal creeks (Woodroffe *et al*., 1985). Species diversity is quite high, although is relatively low compared to those occupying similar latitudes (e.g, in Queensland, Australia) due largely to the greater extremes associated with the wet and dry season and the high variability in rainfall and evapotranspiration (Woodroffe, 1995). Zonation patterns are particularly distinct due largely to the differential ecological performance of species across environmental gradients (Saintilan, 1998) and differential response of species to tidal inundation (frequency and quantity), freshwater flow, soil type and salinity and wave action (Blasco *et al*., 1996; Storrs and Finlayson, 1997). A typical zonation of coastal fringing mangroves would be *Sonneratia alba* and *Camptostemon schultzii* on the seaward margin, *Rhizophora stylosa* further inland, and *Avicennia marina* on the landward margins. In general, tree height increases with proximity to inland channels and each respective mangrove zone occurs parallel to the next. In this study, we focused on the mangroves of the West Alligator River (centred at 13° S, 132.4° E). Within these mangroves, standing biomass and tree height typically increased from the landward edge to a central "ridge" of *Rhizophera*, and then declined towards the seaward edge. Above ground biomass increased to a maximum of ~150 Mg ha^{-1} (Figure 1)

Figure 1: Colour aerial photograph of mangroves, West Alligator River, Australia. The seaward margin is at the top of the photograph.

French Guiana: Mougin *et al*. (1999) and Proisy *et al*. (2000, 2002) conducted their study on mangroves of the Crique Fouillée, French Guiana (4°52' N, 52°19' W). As with many mangroves that occur along the 350 km Atlantic coastline of French

Guiana, species diversity is relatively low. The communities studied were dominated by three main species; *Laguncularia racemosa* (grey mangrove), *Avicennia germinans* (white mangrove) and *Rhizophora species* (red mangroves). At Crique Fouillée, three forest development stages (pioneer, mature and declining) were observed. Within these mangroves, standing biomass and tree height increased progressively from the seaward edge inland (from 10 Mg ha^{-1} to 450 Mg ha^{-1}) while tree density decreased (Fromard *et al.* 1998).

AIRSAR OBSERVATIONS, FIELD DATA AND MODEL SIMULATIONS.

AIRSAR data were acquired over the ARR in 1993 and also in 1996. In this study, attention focused on the 1996 data acquired over the West Alligator River. To support the interpretation of the data, stereo pairs of colour aerial photographs (acquired in 1991) were used to generate a Digital Elevation Model (DEM) of mangrove canopy height (Figure 2; Lucas *et al.*, 2002). Field data acquired in 1999 were used to validate the accuracy of the height map and additional information relating to the species composition and density of mangroves were also collected. These data were used subsequently to support the classification of mangrove species based on the colour photography and also MASTER data acquired in 2000 as part of PACRIM II. By combining the two classifications, the location of different mangrove communities and their species composition could be better mapped. Furthermore, the regeneration stage of the mangrove communities could be inferred from a) the DEM of mangrove canopy height and b) through a time-series comparison of 1950 and 1991 stereo photography, which revealed areas of mangrove extension and retreat.

Polarimetric AIRSAR data from 1996 were registered to the aerial photograph and associated DEM. Using the DEM of mangrove canopy height, AIRSAR C, L and P band co- and cross polarised data were extracted for different height classes across a transect from the landward to the seaward margins. Then, for different mangrove communities (*Rhizopera*, *Avicennia* and *Sonneratia* sp.) and regeneration stages, relationships were established between mangrove canopy height and the backscattering coefficient. Allometric equations were also used to estimate the above ground and component (leaf, branch and trunk) biomass of the mangroves, using height as the independent variable. Stand-level estimates (Mg ha^{-1}) were generated by multiplying the density of stems (derived from field survey) by the calculated biomass. Relationships were then established between total above ground and component biomass and the backscattering coefficient at different frequencies and polarisations.

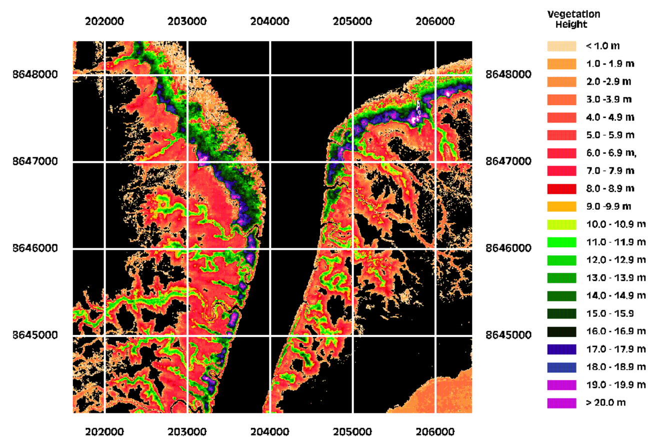

Figure 2: Digital Elevation Model (DEM) of mangrove canopy height (West Alligator River) generated using stereo colour photography.

AIRSAR data were acquired over Crique Fouillée in 1993. Backscatter response was observed and also modelled at different frequencies and polarisations for 12 independent mangrove stands, with 4 pioneer stages (*Laguncularia*), 4 mature stages (*Avicennia*) and 4 declining stages (*Avicennia* and *Rhizophera*). Proisy *et al.* (2000) provides a description of the polarimetric backscattering model used to simulate radar response in this study and provides relationships between different structural parameters and biomass and the SAR backscattering coefficient at different frequencies and polarisations. Biomass and structural parameters were estimated from field data and available allometric equations.

COMPARISON OF SITES

The presentation will provide a comparison of :

a) Relationships observed between the backscatter coefficient and structural parameters (e.g., height and density) at both Crique Fouillée (French Guyana) and the West Alligator River (Australia).

b) Species/community composition and regeneration stage at the two sites and the relative importance of structure in determining the radar response.
c) Relationships between the backscatter coefficient and above ground and component (leaf, branch and trunk) biomass.

An evaluation of SAR backscatter modelling for understanding the response of mangroves will also be presented.

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