ALOS

Mapping and Characterisation of Regrowth, Queensland, Australia

K&C Initiative
An international science collaboration led by JAXA

Project objectives

- To evaluate and demonstrate the integration of ALOS PALSAR and Landsat-derived Foliage Projected Cover (FPC) for mapping different forest growth stages, Queensland, Australia.

History of clearance and regeneration

- Since European settlement, extensive tracts of woody vegetation have been cleared, particularly on the more fertile land.
- In Queensland, this study focused on clearing in the Brigalow Belt Bioregion (Figure 1).
- As a consequence, more than 60 % of native vegetation has been lost and less than 10 % of forests with brigalow (*Acacia harpophylla*) as a dominant or sub-dominant component remain. Only few areas of brigalow habitat are protected in national parks.
- Brigalow nevertheless dominates many of the regrowth communities (Figure 2) that have established following clearance.

Figure 1. The Brigalow Belt Bioregion (BBB; shaded) of Queensland.

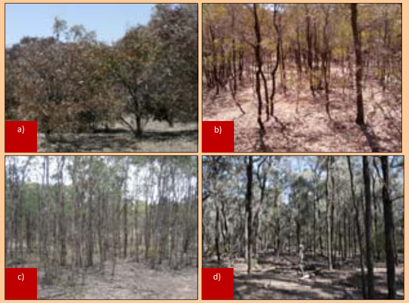

Figure 2. Examples of brigalow regrowth aged a) 5 years, b) 27 years and c) 40 years. Mature remnant forests is illustrated in d). Even after 40 years, forests may be structurally similar to the early regrowth stage (< 5 years) as the high density of stems inhibits growth. Remnant forests typically support a high biomass and foliage cover, although the form varies widely throughout the region.

Importance of regrowth

- Regrowth represents the primary mechanism to restore both biodiversity (Bowen *et al.*, 2007) and carbon stocks (Dwyer *et al.*, 2009).
- The Brigalow Belt Bioregion is of particular importance to both conservation and carbon sequestration as a) forests with brigalow as a component are amongst the most endangered ecosystems in Queensland and support rare, uncommon or endemic flora and fauna, and b) the potential to restore carbon is significant given that mature forests can attain an above ground biomass of 250 Mg ha^{-1} (including dead material).
- A recommended approach to restoring brigalow forests requires identification of 'locked-up' dense stands which can be managed appropriately (e.g., through thinning) to facilitate more rapid structural development and associated recovery of carbon and biodiversity values. Allocation of a value associated with carbon and/or biodiversity to these forests also provides an economic incentive for long-term preservation and restoration (Dwyer et al., 2009).
- In developing strategies for restoring this ecosystem, knowledge of the extent and state of regrowth with brigalow as a component is essential; existing mapping relies on the use of historical aerial photography and optical satellite sensor (primarily Landsat) data for mapping remnant forests. All other forests with a Landsat FPC of >= 9 % are then assumed to be regenerating. However, forests at different stages of structural development (and particularly those regarded as 'locked-up') are not distinguished.

ALOS PALSAR provides unique information to map regrowth stage

- Previous research undertaken using NASA JPL AIRSAR data acquired near Injune in central southeast Queensland (Lucas *et al.*, 2006) established that L-band and Landsat-derived FPC could be integrated to map the extent of early regrowth forests. These forests were successfully identified as they supported an L-band HH backscattering coefficient similar to non-forest but an FPC greater than that associated with forests (typically 12 %). The low L-band return was due to the high density of stems (often > 15,000 ha^{-1}) which are too small for double bounce scattering to occur. Recent investigations using ALOS PALSAR data have also indicated that remnant forests can be identified where these collectively exhibit an L-band HH and HV and Landsat-derived FPC above certain thresholds. All other forests can be regarded as being at the intermediate stages of regrowth.
- The mapping of these forests at a regional level (i.e., the Brigalow Belt Bioregion) has been undertaken using mosaics of both ALOS PALSAR and Landsat-derived FPC (Figure 3). Opportunities also exist for mapping regrowth in other regions of Queensland.
- The methods and maps presented represent a significant advance in regrowth mapping and characterisation in Queensland.
- New methods for retrieving the height and density of forests have also been developed based on inversion of relationships established with L-band HH and HV data (Figure 4). Significant advances have also been made in using the Landsat-FPC data to quantify L-band canopy scattering, thereby paving the way for better retrieval of woody structural elements using these data.

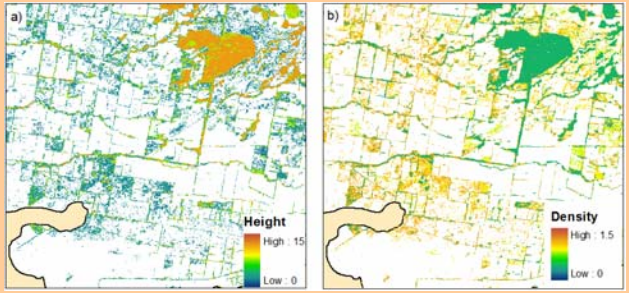

Figure 4. Maps of a) height and b) stem density derived by fitting equations of form σ(Height,Density) = a + b.Density + c.Density.ln(Height) to HH and HV data and inverting. For the inversion, values of height and density were estimated using an optimisation algorithm,such that the least squares distance between σ(height,density) and measured backscatter were minimised in both HH and HV channels.

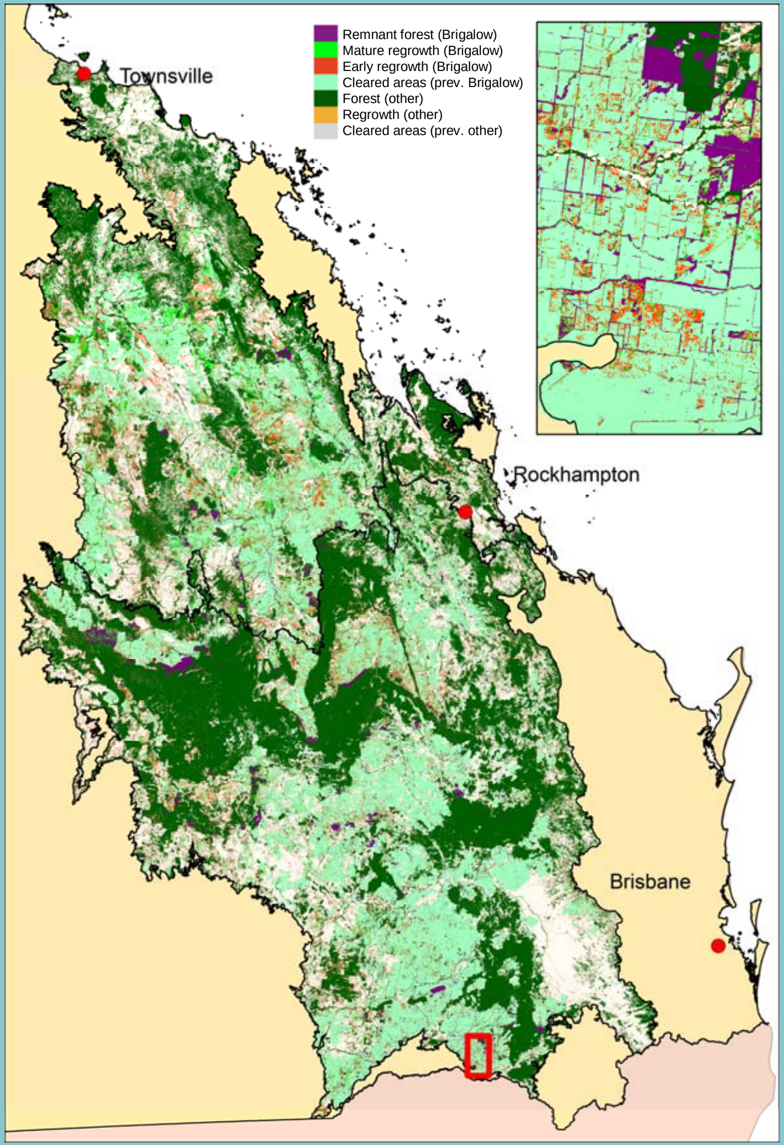

Figure 3. The extent of regrowth and remnant vegetation, Brigalow Belt Bioregion, as mapped using ALOS PALSAR L-band HH, HV and Landsat-derived FPC. The mapping cannot be achieved using either datasets on their own.

Bowen, M.E., McAlpine, C.A., House, A.P.N. and Smith, G.C. (2007) Regrowth forests on abandoned agricultural land: A review of their habitat values for recovering forest fauna, *Biological Conservation*, 140, 273-296.
Dwyer, J.M., Fensham, R.J., Butler, D.W. and Buckley, Y.M. (2009). Carbon for conservation: Assessing the potential for win-win investment in an extensive Australian regrowth ecosystem. *Agriculture, Ecosystems and Environment*, 134, 1-7.
Lucas, R.M., Cronin, N., Moghaddam, M., Lee, A., Armston, J., Bunting, P. and Witte, C. (2006). Integration of radar and Landsat-derived Foliage Projected Cover for woody regrowth mapping, Queensland, Australia, *Remote Sensing of Environment*, 100, 407-425.

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Queensland Government

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