Regional Characterisation and Mapping of Forest Structural Types from ALOS PALSAR data

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Project Objectives

- To map the growth stage of forest structural types
  - Queensland
  - Extend to northern Australia

- Direct mapping of regenerating forest

- Retrieval of above ground biomass
  - Reference to Regional Ecosystem Mapping

- Direct characterization of forest structural types
  - Particular focus on wooded savannas
    - Open to closed forest
Orthorectification of K&C Strip Data

- Queensland
  - Landsat Foliage Projected Cover (FPC)
  - Landsat Panchromatic
  - SRTM

- Northern Territory/Western Australia
  - SRTM

- Geocoding errors < 1 pixel
  - Reduced when Landsat data used

- Greater errors on east coast of Australia
Generation of Strip Mosaics

• Direct comparison with Statewide Products
  – Landsat-derived FPC
  – Queensland Herbarium Regional Ecosystem Mapping
  – Remnant Vegetation
  – Land cover change datasets

• Requirement for across track correction and mosaicing procedures
Cross Track Correction & Mosaicing

• SRTM mosaic generation
  – CGIAR-CSI SRTM 90 m
    • http://srtm.csi.cgiar.com
  – QDNRW

• SRTM correction
  – Zero and negative values

• Cross Track Correction
  – JRC procedures
Mosiacing

Prior to correction

Post-correction
Mosaic outputs: Injune, south central Queensland
Mosaic outputs: Injune, south central Queensland
Framework for Mapping Forests

Regional Ecosystems

Landsat frames
Regrowth and Biomass Mapping: Ground Truth

• Forest regrowth sites, Queensland Herbarium
  – Plot-based measurements across widely distributed sites
    • Non-remnant
  – Biomass estimation from existing allometric equations

• TRAPS permanent plot data
  – Biomass

• Injune Landscape Collaborative Project
  – LiDAR-derived biomass
Mapping of Regeneration Stage
Mapping of Regeneration Stage
Regrowth Mapping Examples

- Regrowth sites
Estimation of Above Ground Biomass

\[ \ln(\text{TAGB}) = a_0 + a_1 \sigma_{HH} + a_2 (\sigma_{HH})^2 + a_3 \sigma_{HV} + a_4 (\sigma_{HV})^2 \]
Regional scaling of forest biomass using ALOS PALSAR

Injune PSU grid

Strip Mosaics
Queensland Vegetation Distributions

Summarised Regional Ecosystem Coverage

Vectors overlain onto ALOS strip mosaics
Retrieval of Forest Structural Attributes

JERS-1 SAR overlain with Queensland Regional Ecosystem Boundaries

LiDAR-derived FPC (%)

LiDAR-derived Height (99 Percentile)

Crown Density (No. ha⁻¹)

ALOS PALSAR HH Backscatter (Signal, dB)

Lidar FPC Calibration

$R^2 = 0.844$

$y = 1.18 + 0.883x$

RMSE: 5.18

Lidar fractional cover (%)

annual rainfall (mm)

0-200 200-300 300-400 400-500 500-600 600-800 >800

lidar field sites
Forest Structural Classification

- Dead standing trees
- Decurrent/Excurrent
- Decurrent
- Early regrowth
- Excurrent (Pines)
- Foreground
- Forest
- Late regrowth
- Medium regrowth
- Non-forest
- Regrowth
Class Membership Images

Excurrent (Pines)

Decurrent (Eucalyptus)

Excurrent/Decurrent
Comparison with Regional Ecosystem Mapping

- Broad correspondence
- RE based on interpretation of optical data
  - Dominant species/genera
  - Broad structure (discrete)

- Integration of ALOS PALSAR and Landsat data/products
  - Structural classification (continuous)
  - Reference to class membership
Summary

- ALOS Strip Data
  - Cross track correction
  - Orthorectification
  - Mosaicing

- Derived products
  - Regrowth stage (non-renmant)
Summary

• **ALOS Strip Data**
  – Cross track correction
  – Orthorectification
  – Mosaicing

• **Derived products**
  – Regrowth stage (non-renmant)
  – Biomass
    • To saturation level
Summary

- **ALOS Strip Data**
  - Cross track correction
  - Orthorectification
  - Mosaicing

- **Derived products**
  - Regrowth stage (non-renmant)
    - **Biomass**
      - To saturation level
    - **Structural classification**
      - Broad classes
      - Focus on wooded savannas
  - Forest change
    - Dependent upon processing of 2008 mosaic
Current/Future Activities: Airborne LiDAR/Optical Data Acquisitions

- **RIEGL LMS Q560 LiDAR**
  - 2008/2009
  - 0.3 - 0.5 m post spacing
  - Swath width 300-750 m
  - Full waveform

- **Airborne optical**
  - Hyperspectral

- **Terrestrial Laser Scanner**
Integrating Terrestrial & Airborne Laser Scanner Data

Near coincidence with ALOS PALSAR (Cycles 21-22)
Tree to Stand Level Products

- Tree height (LiDAR)
- Species (Hyperspectral)
- Location and density of stems (LiDAR)
- Stand-level biomass
- Leaf
- Branch
- Trunk
- Total

(Integration with data from optical sensors)

- Tree height (LiDAR)
- Species (Hyperspectral)
- Location and density of stems (LiDAR)
- Stand-level biomass
Detection of Environmental Change

- Time-series comparison of LiDAR/optical data/products
  - 2000 (Injune)
  - 2004/5
  - 2008/9

- Time-series comparisons
  - JERS-1 SAR
  - ALOS PALSAR (2007 onwards)
  - Landsat-derived FPC

- Detection of:
  - Woody thickening
  - Drought impacts, Injune, Queensland
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- Queensland University